



OPTRON, INC.

1201 Tappan Circle
Carrollton, Texas 75006
214/242-6571

DEL STEFFEN & ASSOC., INC.
653 ALPHA DRIVE - #33
CLEVELAND, OHIO 44143
PHONE: (216) 461-8333

COMPLETE OPTOELECTRONICS FOR INDUSTRY



OPTRON, INC.

1201 Tappan Circle
Carrollton, Texas 75006
214/242-6571

SILICON PHOTOTRANSISTORS

.4 - 1.1 Micrometer Response OP600 Series — Case Type 1

Parameter	Light Current			Dark Current	Collector Breakdown	Emitter Breakdown	Light Current Rise Time	Saturation Voltage	Angular Response
Test Condition	$V_{CE} = 5V$ H As Shown			$V_{CE} = 10V$ H = 0	$I_C = 100 \mu A$	$I_C = 100 \mu A$	$R_L = 1K$, $V_{CE} = 5V$, $I_L = 0.8 mA$	$I_C = 0.4 mA$	Peak to Half Power Points
Symbol	I_L			I_D	BV_{CEO}	BV_{ECO}	t_r	$V_{CE(SAT)}$	θ
Unit	mA			nA	Volts	Volts	Microseconds	Volts	Degrees
	Min.	Max.	H	Max.	Min.	Min.	Typical	Typical	Typical
OP600	0.8	—	20	25	50	7	2.5	0.4	24
OP601	0.5	3.0	20	25	50	7	2.0	0.4	24
OP602	2.0	5.0	20	25	50	7	2.0	0.4	24
OP603	4.0	8.0	20	25	50	7	2.5	0.4	24
OP604	7.0	22.0	20	25	50	7	2.5	0.4	24
OP605	15.0	—	20	25	50	7	3.0	0.4	24
OP640	0.8	—	20	100	25	5	2.5	0.4	24
OP641	0.5	3.0	20	100	25	5	2.0	0.4	24
OP642	2.0	5.0	20	100	25	5	2.0	0.4	24
OP643	4.0	8.0	20	100	25	5	2.5	0.4	24
OP644	7.0	22.0	20	100	25	5	2.5	0.4	24
OP645	15.0	—	20	100	25	5	3.0	0.4	24
OP666	Calibrated		20	25	50	7	2.5	0.4	24

OP800 Series — Case Type 2

OP800	0.8	—	5	100	30	7	3.0	0.4	10
OP801	0.5	3.0	5	100	30	7	3.0	0.4	10
OP802	2.0	5.0	5	100	30	7	3.0	0.4	10
OP803	4.0	8.0	5	100	30	7	3.0	0.4	10
OP804	7.0	22.0	5	100	30	7	3.0	0.4	10
OP805	15.0	—	5	100	30	7	3.0	0.4	10

OP700 Series — Case Type 3

OP700	0.15	—	20	100	25	5	2.5	0.4	
OP701	0.15	0.6	20	100	25	5	2.0	0.4	
OP702	0.4	1.6	20	100	25	5	2.0	0.4	
OP703	1.0	4.0	20	100	25	5	2.5	0.4	
OP704	3.0	12.0	20	100	25	5	2.5	0.4	
OP705	8.0	—	20	100	25	5	3.0	0.4	

OP400 Series — Case Type 4

OP400	1.0		9.0	25 @ 30V	50	7	2.5	0.4	
OP440	1.0		CS7-69 filter 9.0 CS7-69 filter						
				100	25	5	2.5	0.4	

PHOTODIODES

Parameter	Light Current		Dark Current	Forward Drop	Reverse Breakdown	Case Type
Test Condition	$V_{CE} = 10V$, H As Shown		$V_{CE} = 10V$, H = 0	@ 1 mA	10 μA	
Symbol	I_L		I_D	V_F	BV_R	
Unit	μA		nA	Volts	Volts	
	Min.	H	Max.	Max.	Min.	
OP900	8	20	10	1.0V	100V	1
OP790	13	20	10	1.0V	100V	3

SILICON PHOTO DARLINGTON TRANSISTORS

OP300 Series — Case Type 1 — Note: Also available in TO-18 package similar to Case Type 2

Parameter	Light Current			Dark Current	Collector Breakdown	Emitter Breakdown	Light Current Rise Time	Saturation Voltage	Angular Response
Test Condition	$V_{CE} = 5V$ H As Shown			$V_{CE} = 10V$	$I_C = 100 \mu A$	$I_E = 100 \mu A$	$I_L = 1 mA$, $R_L = 100 \text{ ohms}$, $V_{CC} = 5V$	$I_C = 1 mA$	
Symbol	I_L			I_D	BV_{CEO}	BV_{ECO}	t_r	$V_{CE(SAT)}$	θ
Unit	mA			nA	Volts	Volts	μSec	Volts	Degrees
	Min.	Max.	H	Max.	Min.	Min.	Typical	Max.	Typical
OP300	0.8	—	1	250	15	5	20	1.1	24
OP301	0.8	2.4	1	250	15	5	20	1.1	24
OP302	1.8	5.4	1	250	15	5	20	1.1	24
OP303	3.6	12.0	1	1.0 μA	15	5	20	1.1	24
OP304	7.0	21.0	1	1.0 μA	15	5	20	1.1	24
OP305	14.0	43.0	1	1.0 μA	15	5	20	1.1	24

LIGHT EMITTING DIODES

.935 Micrometer Radiation

Parameter	Optical Power		Beam Angle	Forward Drop		Reverse Breakdown	Radiation Risetime	Forward Cur. Continuous	Case Type
Test Condition	@ I _F mA		Half Power Points	@ I _F mA		I _R = 10 mA		25°C	
Symbol	P _O		θ	V _F		BV _R	t _r		
Unit	mW		Degrees	Volts		Volts	μSec	mA	
	Min.	I _F	Typical	Max.	I _F	Min.	Typical	Max.	
OP122	0.25	50	18	1.6	50	2.0	.7	100	5
OP123	0.4	50	18	1.6	50	2.0	.7	100	5
OP124	1.0	50	18	1.6	50	2.0	.7	100	5
OP131	3.3	100	10	1.75	100	2.0	.7	200	2

OPTOELECTRONIC REFLECTIVE READHEAD ASSEMBLIES

Case Type 6

Parameter	Light Current			Dark Current		Collector Breakdown	Emitter Breakdown	Current Risetime	Saturation Voltage	Forward Drop	
Test Condition	V _{CE} = 5.0V White Bond Paper			V _{CE} = 5.0V		I _C = 100 μA	I _E = 100 μA	V _{CE} = 5.0V, R _L = 1K, I _L = 0.8 mA	I _C = 1 mA	@ I _F mA	
Symbol	I _L @ 0.20"			I _D		BV _{CEO}	BV _{ECO}	t _r	V _{CE(SAT)}	V _F	
Unit	mA			nA		Volts	Volts	μSec	Volts	Volts	
	Min.	Max.	I _F	Max.	I _F	Min.	Min.	Typical	Max.	Max.	I _F
OPB125	2	10	40	250	0	15	5	20	1.1	1.6	50
OPB253	.025	.25	40	100	0	25	5	2.5	0.4	1.6	50

OPTOELECTRONIC ENCODER ASSEMBLIES

Case Type 7

Parameter	Light Current		Dark Current		Collector Breakdown	Emitter Breakdown	Current Risetime	Saturation Voltage	Forward Drop	
Test Condition	V _{CE} = 5.0V		V _{CE} = 25V		I _C = 100 μA	I _E = 100 μA	V _{CE} = 5.0V, R _L = 1K, I _L = 0.8 mA	I _C = 1 mA	@ I _F mA	
Symbol	I _L		I _D		BV _{CEO}	BV _{ECO}	t _r	V _{CE(SAT)}	V _F	
Unit	mA		μA		Volts	Volts	μSec	Volts	Volts	
	Min.	I _F mA	Max.		Min.	Min.	Typical	Max.	Max.	I _F
OPB120	0.80	40	.1		25	5	2.5	.4	1.6	50
OPB243	3.2	40	.3		15	3	20.0	1.1	1.6	50
OPB121	0.80	40	.1		25	5	2.5	.4	1.6	50

OPTICAL COUPLERS — ISOLATORS

Parameter	Collector Current On-State		Collector Current Off-State		Input Forward Voltage	Isolation Voltage	Risetime		Case Type
Test Condition	V _{CE} = 5V @ I _F mA		I _F = 0V _{CE}		I _F = 50 mA	Input to Output	V _{CC} = 5V, R _L = 100 ohms, @ I _F mA		
Symbol	I _C ON		I _C OFF		V _F		t _r		
Unit	mA		μA		Volts	KV	μSec		
	Min.	I _F	Max.	V _{CE}	Max.	Min.	Typical	I _F	
OP1030	4.0	10	1.0	10	1.6	5	20	10	8
OP1031	4.0	4.0	1.0	10	1.6	5	20	4.0	8
OP1060	.40	15	0.1	10	1.6	5	2.5	15	8
OP1061	1.5	15	0.1	10	1.6	5	3.5	15	8
OP1090	.002	40	.01	30	1.6	5	0.5	40	8
OP1050-10	.01	30	.01	10	1.6	10	0.5	30	9
OP1053-10	2.0	20	1.0	10	1.6	10	20	20	9
OP1056-10	0.8	20	.025	10	1.6	10	3.5	20	9
OP1050-50	.01	30	.01	10	1.6	50	0.5	30	10
OP1053-50	2.0	20	1.0	10	1.6	50	20	20	10
OP1056-50	0.8	20	.025	10	1.6	50	3.5	20	10
OP1040	.40	15	0.1	10	1.6	15	2.5	15	11

LIGHT SENSOR AND EMITTER ARRAYS & PAIRS

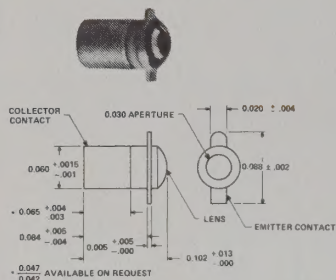
Parameter	Light Current			Dark Current	Collector Breakdown	Emitter Breakdown	Power Output		Forward Drop		Element No. & Spacing		Case Type
Test Condition	V _{CE} = 5V, H As Shown			V _{CE} = 10V	I _L = 100 μA	I _E = 100 μA	@ I _F mA		@ I _F μA				
Symbol	I _L Min. I _L Max. = 0.5 Min.			I _D	BV _{CEO}	BV _{ECO}	P _O Min. P _O Max. = 0.5		V _F				
Unit	mA			nA	Volts	Volts	mW		Volts		Inches		
	Min.	I _F	H	Max.	Min.	Min.	Min.	I _F	Max.	I _F	±.003	Non-Cumulative	
OPA505	0.8		20	100	25	5	.25	50	1.6	50	6	.100	12
OPE505											6	.100	12
OPB505	1.6-6.4	30		Paired OPA505 and OPE505 — Sensor to Emitter Spacing —								.100	12
OPA508	0.8		20	100	25	5	.25	50	1.6	50	9	.100	13
OPE508											9	.100	13
OPB508	1.6-6.4	30		Paired OPA508 and OPE508 — Sensor to Emitter Spacing —								.100	13
OPA512	0.8		20	100	25	5	.25	50	1.6	50	14	.250	14
OPE512											14	.250	14
OPB512	1.6-6.4	30		Paired OPA512 and OPE512 — Sensor to Emitter Spacing —								.100	14
OPA518	0.8		20	100	25	5	.25	50	1.6	50	20	.087	15
OPE518											20	.087	15
OPB518	1.6-6.4	30		Paired OPA518 and OPE518 — Sensor to Emitter Spacing —								.100	15

OPTRON, INC.

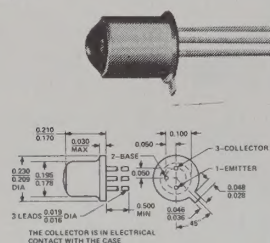
1201 Tappan Circle
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PHYSICAL DESCRIPTION

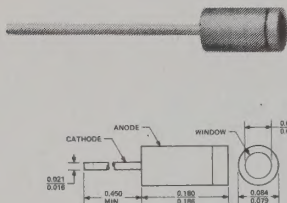
Case Type 1



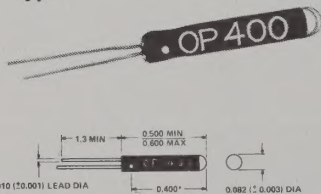
Case Type 2



Case Type 3

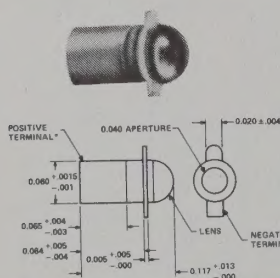


Case Type 4

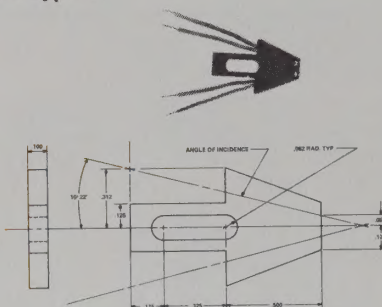


NOTE: POSITIVE TERMINAL IDENTIFIED BY RED DOT
*BODY DIA. IS 0.081 - 0.003 WITHIN THIS ZONE AND NON-CUM. TOLERANCE
WITH RESPECT TO CENTER LINE OF BARREL.

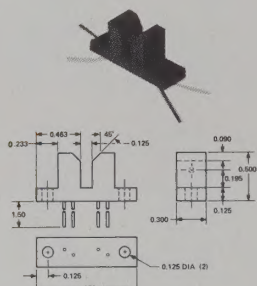
Case Type 5



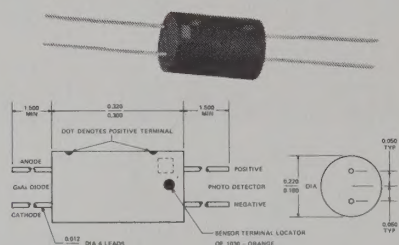
Case Type 6



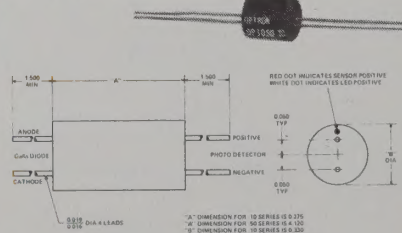
Case Type 7



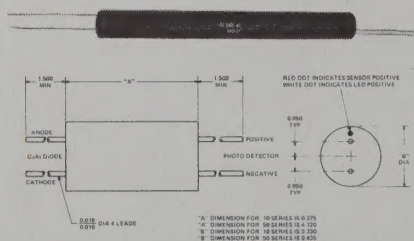
Case Type 8



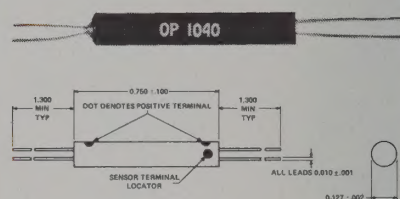
Case Type 9



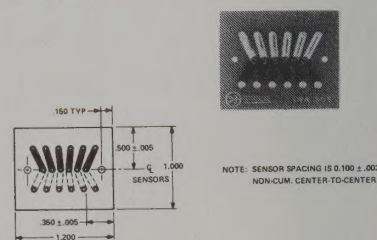
Case Type 10



Case Type 11

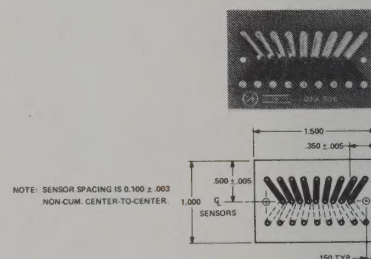


Case Type 12



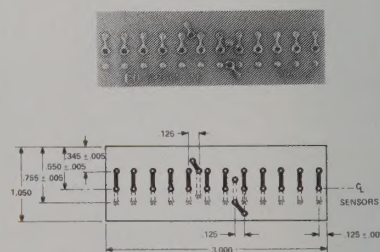
NOTE: SENSOR SPACING IS $0.100 \pm .001$
NON-CUM. CENTER-TO-CENTER

Case Type 13



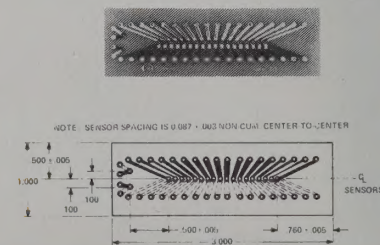
NOTE: SENSOR SPACING IS $0.100 \pm .005$ IN.
NON-CUM. CENTER-TO-CENTER

Case Type 14

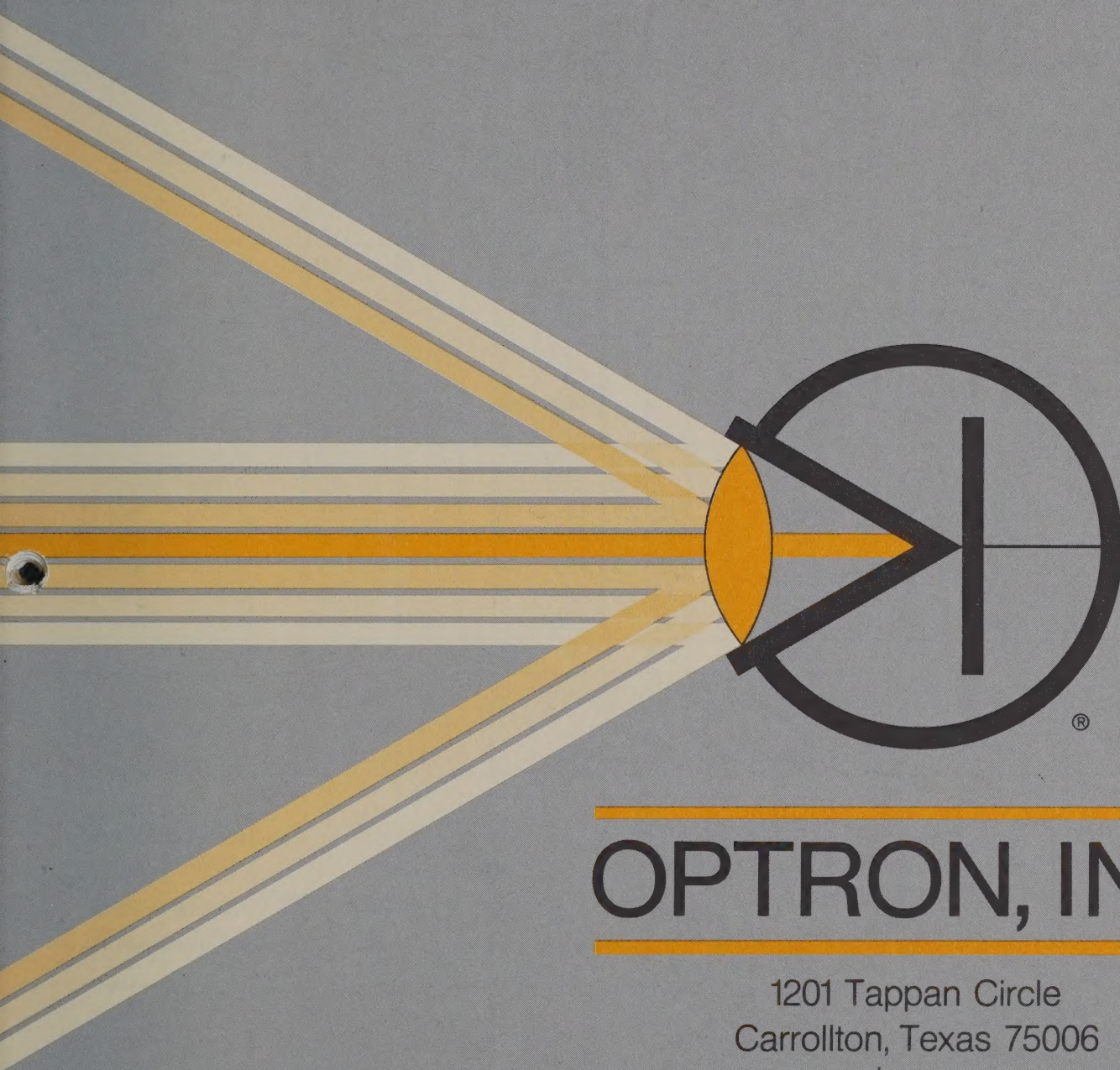


NOTE: SENSOR SPACING IS 0.250 ± 0.003 NON-CUM. CENTER TO-CENTER

Case Type 15



NOTE: SENSOR BRACING IS 0.0027 x (0.03 MIN CLIM) CENTER TO CENTER



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Optoelectronics for Industry

MAXIMUM RATINGS (T _A = 25°C) (Notes 1, 2, 5 & 9) Breakdown Voltages Tested @ I _R = 100 μa								ELECTRICAL CHARACTERISTICS T _A = 25°C Free Air (unless otherwise specified) Test Conditions Code Letter Shown in ()					
Description	Type No.	Case No.	BV _{CEO}	BV _{ECO}	P _{DISS}	I _F	BV _R	Light Current I _L		Dark Current I _D	Non-saturated Switching Time		Power Output P _O
			volts	volts	(Note 2) mw	ma	volts	MIN ma	MAX ma	MAX na	TYP t _r μsec	TYP t _f μsec	MIN mw
GaAs Energy Source	OP 100	1			50	50	2						Note 3 (A)
Darlington Phototransistor	OP 300	2	15	5	50			4.0 (D)		250 (B)	50 (K)	50 (K)	
NPN Silicon Phototransistors	OP 400	3	30	7	50			1.0 (G)		25 (E)	2.5 (L)	8.0 (L)	
	OP 420	3	45	5	50			0.8 (J)		25 (E)	1.5 (L)	2.0 (L)	
	OP 600	2	50	7	50			0.8 (J)		25 (E)	2.5 (N)	2.5 (N)	
	OP 601	2	50	7	50			1.5 (J)	3.0 (J)	25 (E)	3.2 (N)	2.4 (N)	
	OP 602	2	50	7	50			2.5 (J)	5.0 (J)	25 (E)	6.5 (N)	6.2 (N)	
	OP 603	2	45	7	50			4.0 (J)	8.0 (J)	25 (E)	8.3 (N)	8.9 (N)	
	OP 604	2	40	7	50			6.0 (J)	12.0 (J)	25 (E)	12.7 (N)	14.0 (N)	
	OP 605	2	40	7	50			10 (J)		25 (E)	14.5 (N)	18.0 (N)	
	OP 606	2		7	50			1.25 (M)		25 (E)	12.7 (P)	14.0 (P)	
	OP 607	2		7	50			0.25 (M)		25 (E)	6.5 (P)	6.2 (P)	
	OP 608	2		7	50			0.5 (M)		25 (E)	6.5 (P)	6.2 (P)	
	OP 620	1	45	5	50			0.5 (J)		25 (E)	1.5 (P)	2.0 (P)	
	OP 666	2	50	7	50			(Calibrated)		25 (E)			
	OP 700	4	40	6	50			0.5 (J)		25 (E)			
PN Silicon Diodes	OP 490	3			50		100	0.008 (W)		8 (V)	0.050 (X)	0.050 (X)	
	OP 900	1			50		100	0.008 (W)		8 (V)	0.050 (X)	0.050 (X)	
GaAs Diode—Detector Couplers	OP 1020	5	40	6.0	50	40	2.0	0.1 (AA)		25 (E)	1.0 (DD)	2.0 (DD)	Note 15
	OP 1030	5	15	5.0	50	40	2.0	4.0 (BB)		250 (B)	50 (DD)	50 (DD)	Note 15
	OP 1060	5	50	6.0	50	40	2.0	0.25 (AA)		25 (E)	3.5 (DD)	4.5 (DD)	Note 15
	OP 1061	5	50	6.0	50	40	2.0	2.0 (CC)		25 (E)	3.5 (DD)	8.0 (DD)	Note 15
	OP 1090	5	100		50	40	2.0	0.002 (AA)		10 (V)	0.030	0.030	Note 15

MAXIMUM RATINGS PER JUNCTION (T _A = 25°C) (Notes 1, 2, 5 & 9) Breakdown Voltages Tested = 100 μa								ELECTRICAL CHARACTERISTICS T _A = 25°C Free Air (unless otherwise specified) Test Conditions Code Letter Shown in ()					
Description	Type No.	Case No.	BV _R	BV _{CEO}	BV _{ECO}	P _{DISS}	I _F	T _A	T _J	I _D	I _L	Matching Factor	Power Output P _O
			volts	volts	volts	(Note 2) mw		(operating) °C	(storage) °C	MAX na	(Note 3) MIN ma	(Note 8) MIN	MIN mw
6 Channel Tape Reader Array	OPA 505	6		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.5 (J)	
6 Channel Tape Reader Array	OPA 505A	6		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.75 (J)	
9 Channel Tape Reader Array	OPA 508	7		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.5 (J)	
9 Channel Tape Reader Array	OPA 508A	7		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.75 (J)	
12 Channel Card Reader Array	OPA 512	8		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.5 (J)	
12 Channel Card Reader Array	OPA 512A	8		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.75 (J)	
18 Channel Card Reader Array	OPA 518	9		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.5 (J)	
18 Channel Card Reader Array	OPA 518A	9		35	6.0	50		85	100	100 (EE)	0.8 (J)	0.75 (J)	
6 Channel Emitter Source Array	OPE 505	6	2.0										Note 3 (A)
9 Channel Emitter Source Array	OPE 508	7	2.0										Note 3 (A)
12 Channel Emitter Source Array	OPE 512	8	2.0										Note 3 (A)
18 Channel Emitter Source Array	OPE 518	9	2.0										Note 3 (A)
7 Channel Hybrid Tape Reader	OPTA 107	10		35	6.0	50		85	85	100 (EE)	0.5 (J)	0.5 (J)	
54 Diode Monolithic Array	OPDA 54	11	40					85	85	10 (EE)	0.0004	0.6 (J)	
Sensor-LED Encoder Assbly.	OPB 120	12		40	6.0	50	50	85	85	100 (EE)	0.8 (AA)		
Sensor-LED Mark Sense Rdr. Assbly.	OPB 125	13		20	5.0	50	50	85	85	250 (B)	0.2 (GG)		Note 10



OPTRON, INC.

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Supplemental Bulletin — for use with Bulletin No. 1012

MAXIMUM RATINGS
($T_A = 25^\circ\text{C}$) (Notes 1, 5 & 9)
Breakdown Voltages Tested @ $I_R = 100\ \mu\text{a}$

ELECTRICAL CHARACTERISTICS
 $T_A = 25^\circ\text{C}$ Free Air (unless otherwise specified)
Test Conditions Code Letter Shown in ()

Description	Type No.	Case No.	BV_{CEO} volts	BV_{ECO} volts	P_{DISS} (Note 2) mw	I_F ma	BV_R volts	Light Current I_L		Dark Current I_D na	Non-saturated Switching Time		Power Output P_O mw
								MIN ma	MAX ma		TYP t_r μSec	TYP t_f μSec	
GaAs Energy Sources (Note 2)	OP 122	1				100	2						0.250
	OP 123	1				100	2						0.400
Darlington Phototransistors	OP 301	2	15	5	50			0.8 (D)	2.4 (D)	250 (B)	50 (K)	50 (K)	Note 9, 11
	OP 302	2	15	5	50			1.8 (D)	5.4 (D)	250 (B)	50 (K)	50 (K)	Note 9, 11
	OP 303	2	15	5	50			3.6 (D)	12.0 (D)	250 (B)	60 (K)	60 (K)	Note 9, 11
	OP 304	2	15	5	50			7.0 (D)	21.0 (D)	250 (B)	100 (K)	100 (K)	Note 9, 11
	OP 305	2	15	5	50			14.0 (D)	43.0 (D)	250 (B)	200 (K)	200 (K)	Note 9, 11
NPN Silicon Phototransistors (Plastic Lens)	OP 563	14	50	7	50			0.4 (J)		25 (E)	3.5 (N)	4.5 (N)	Note 9, 11
	OP 564	14	50	7	50			0.4 (J)	1.6 (J)	25 (E)	1.5 (N)	2.0 (N)	Note 9, 11
	OP 565	14	50	7	50			1.0 (J)	4.0 (J)	25 (E)	2.5 (N)	3.5 (N)	Note 9, 11
	OP 566	14	50	7	50			2.5 (J)	10.0 (J)	25 (E)	3.5 (N)	4.5 (N)	Note 9, 11
	OP 567	14	50	7	50			6.0 (J)		25 (E)	8.0 (N)	12.0 (N)	Note 9, 11
	OP 568	14	25	5	50			0.4 (J)		100 (B)	3.5 (N)	4.5 (N)	Note 9, 11
	OP 569	14	25	5	50			0.4 (J)	1.6 (J)	100 (B)	1.5 (N)	2.0 (N)	Note 9, 11
	OP 570	14	25	5	50			1.0 (J)	4.0 (J)	100 (B)	2.5 (N)	3.5 (N)	Note 9, 11
	OP 571	14	25	5	50			2.5 (J)	10.0 (J)	100 (B)	3.5 (N)	4.5 (N)	Note 9, 11
	OP 572	14	25	5	50			6.0 (J)		100 (B)	8.0 (N)	12.0 (N)	Note 9, 11
NPN Silicon Phototransistors	OP 631	2	25	5	50			0.4 (J)	1.2 (J)	100 (B)	1.5 (N)	2.0 (N)	Note 9, 11
	OP 632	2	25	5	50			0.8 (J)	2.4 (J)	100 (B)	2.0 (N)	2.5 (N)	Note 9, 11
	OP 633	2	25	5	50			1.8 (J)	5.4 (J)	100 (B)	3.5 (N)	4.5 (N)	Note 9, 11
	OP 634	2	25	5	50			7.0 (J)	22.0 (J)	100 (B)	8.0 (N)	12.0 (N)	Note 9, 11
GaAs Diode—Detector Couplers	OP 1022	15	25	5	150	100	2	0.5 (CC)		100 (B)	1.0 (DD)	2.0 (DD)	Note 12, 14
	OP 1023	16	25	5	50	50	2	1.0 (AA)		100 (B)	2.0 (AA)	2.0 (AA)	Note 2, 13
	OP 1025	17	25	5	50	40	2	0.1 (CC)		100 (B)	1.0 (DD)	2.0 (DD)	Note 11, 15
	OP 1032	15	15	5	150	100	2	5.0		250 (B)	50 (DD)	50 (DD)	Note 12, 14, 16
	OP 1033	16	15	5	50	40	2	2.0 (BB)		250 (B)	50 (DD)	50 (DD)	Note 11, 13
	OP 1035	17	15	5	50	40	2	2.0 (BB)		250 (B)	50 (DD)	50 (DD)	Note 11, 15
	OP 1061	17	25	5	50	40	2	2.0 (CC)		100 (B)	3.5 (DD)	4.5 (DD)	Note 11, 15
	OP 1062	15	25	5	150	100	2	2.5 (BB)		100 (B)	3.5 (DD)	4.5 (DD)	Note 12, 14
	OP 1063	16	25	5	50	50	2	2.0 (CC)		100 (B)	3.5 (DD)	4.5 (DD)	Note 2, 13
	OP 1064	15	25	5	150	100	2	2.5 (BB)		100 (B)	3.5 (DD)	4.5 (DD)	Note 12, 14
	OP 1065	17	25	5	50	40	2	0.1 (CC)		100 (B)	3.5 (DD)	4.5 (DD)	Note 11, 15

NOTES 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 — See Bulletin No. 1012.

NOTE 11. Derate linearly to 100°C free-air temperature at the rate of $0.67\ \text{mw}/^\circ\text{C}$.

NOTE 12. Derate linearly to 100°C free-air temperature at the rate of $1.3\ \text{mw}/^\circ\text{C}$.

NOTE 13. Isolation between input and output to exceed 20,000 volts at 1.0 pf capacitance (typical).

NOTE 14. Isolation between input and output to exceed 1500 volts at 1.3 pf capacitance (typical).

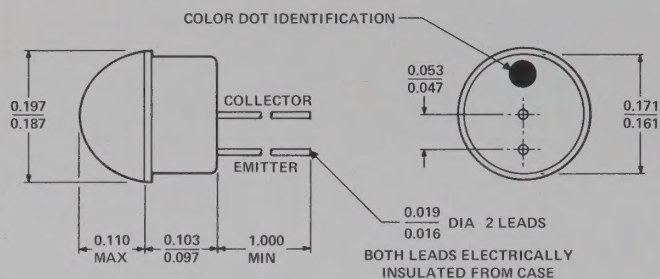
NOTE 15. Isolation between input and output to exceed 2500 volts at 3.4 pf capacitance (typical).

NOTE 16. $V_{CE} = 5.0$ volts, I_F (LED) = 1.0 ma DC.

Supplemental Bulletin — for use with Bulletin No. 1012

Physical Description

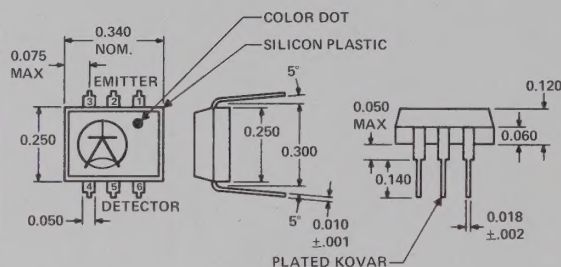
COLOR CODE	
PART NO.	COLOR DOT
OP 563	ORANGE
OP 564	YELLOW
OP 565	GREEN
OP 566	BLUE
OP 567	VIOLET
OP 568	GRAY
OP 569	WHITE
OP 570	BLACK
OP 571	BROWN
OP 572	RED



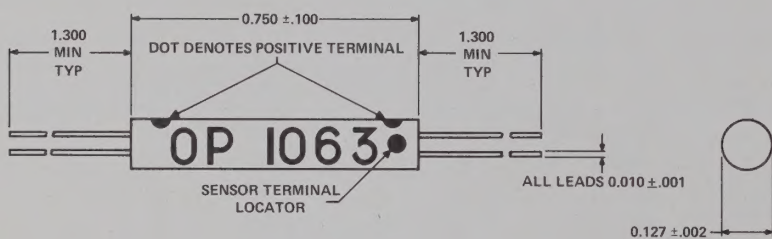
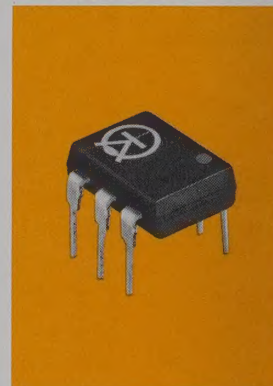
Case No. 14



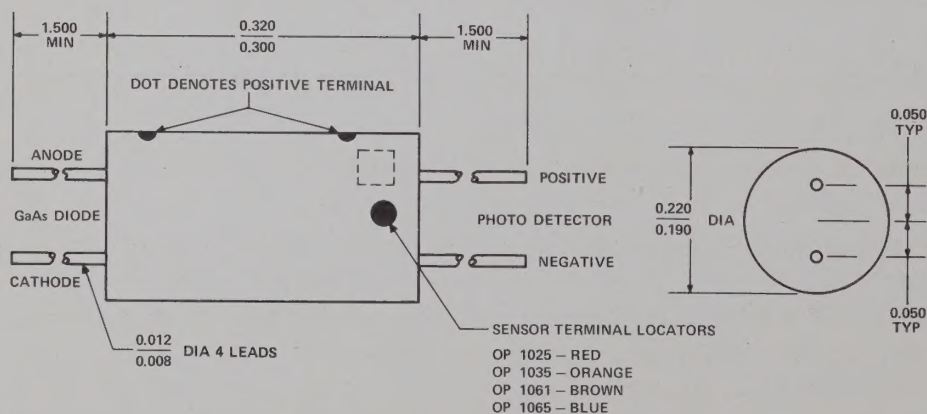
PIN NO.	OP 1022	OP 1032	OP 1062	OP 1064
1	ANODE	ANODE	ANODE	ANODE
2	CATHODE	CATHODE	CATHODE	CATHODE
3	NC	NC	NC	NC
4	EMITTER	EMITTER	EMITTER	EMITTER
5	COLLECTOR	COLLECTOR	COLLECTOR	COLLECTOR
6	NC	NC	NC	BASE
COLOR CODE	RED	ORANGE	BLUE	YELLOW



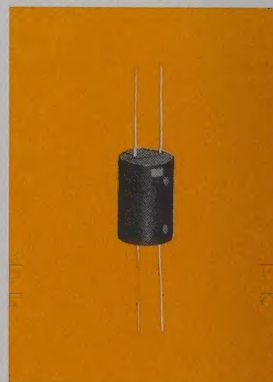
Case No. 15



Case No. 16



Case No. 17



TEST CONDITIONS									
Code Letter	Irradiance H (Note 6) mw/cm ²	Reverse Voltage V _R V _{CE} volts	Supply Voltage V _{CC} volts	Load Resistance R _{EE} ohms	Ambient Temperature T _A °C	GaAs Diode Forward Current I _F ma	Color Temperature CT °K	Light Current I _L ma	Remarks
(A)						50			
(B)	0	10							
(C)	0	10			100				
(D)	1.0	5.0					2870		
(E)	0	30							
(F)	0	30			125				
(G)	9	5.0					2870		See Note 4
(H)	0	30			100				
(J)	20	5.0					2870		
(K)			5.0	100				4.0	
(L)			5.0	1000				0.8	See Note 5
(M)	5.0	5.0	5.0	1000			2870		
(N)			5.0	1000				0.8	See Note 5
(P)			20	100				1.0	See Note 5
(R)	1 to 20	5.0							See Notes 5 & 6
(S)	20	5.0					2100 to 2870		See Notes 5 & 6
(T)	0	±50							
(U)	9.0	±10					2870		See Note 4
(V)	0	50							
(W)	20	50					2870		
(X)		50		100				0.003	See Note 7
(AA)		5.0				40			
(BB)		5.0				10			
(CC)		5.0				20			
(DD)			5.0	1000		5.0			
(EE)	0	25							
(FF)	1.0	5.0						2.0	
(GG)		5.0				50			See Note 10

- NOTE 1.** Ratings at which device performance may be impaired. Maximum power dissipation of all devices is 50 mw.
- NOTE 2.** Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.
- NOTE 3.** The equivalent P_O figure is obtained by placing the OP 100 lens 0.1 inches from the lens of an Optron OP 666 Photometric Standard. The light current generated in the OP 666 under these conditions will be ≥ than the light current generated in the same OP 666 when subject to an irradiance level H = 1.0 mw/cm² from an unfiltered tungsten linear filament bulb operating at a color temperature of 2870°K. For higher power levels, see Application Bulletin No. 15 for pulse duty operation.
- NOTE 4.** A 0.7 to 1.0 micron (CS7-69 or equivalent) filter is placed between source and sensor.
- NOTE 5.** V_{sat} is maximum of 0.4 volts with I_{sat} of 0.4 ma except OP 300. Input irradiance (H) is supplied by a pulsed gallium arsenide light emitting diode (LED). The output of the LED is adjusted until I_L is 0.8 ma.
- NOTE 6.** Irradiance (H) is the radiant power per unit area incident upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at a specific color temperature. G. E. No. 18AT101P or equivalent is recommended as a lamp source.
- NOTE 7.** Input irradiance (H) is supplied by a pulsed gallium arsenide light emitting diode (LED). The output of the LED is adjusted until I_L is 2.0 μa.
- NOTE 8.** Matching factor is determined by the ratio of $\frac{I_{L \text{ min}}}{I_{L \text{ max}}}$. The 0.75 to 1.0 limit applies to the OPA 512A and OPA 518A only.
- NOTE 9.** Rating for soldering is extended to 240°C for 3 minutes maximum. Maximum storage temperature is 150°C. Maximum operating temperature is 125°C for all devices except OP 300. It is rated for 70°C operation. Storage temperature of plastic assemblies is 85°C to minimize discoloration.
- NOTE 10.** White bond paper placed 0.150 inch from Mark Sense Reader.



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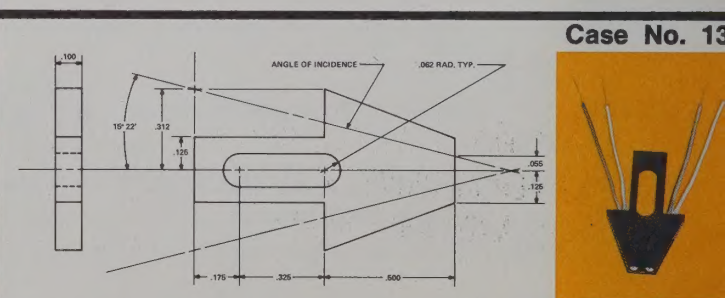
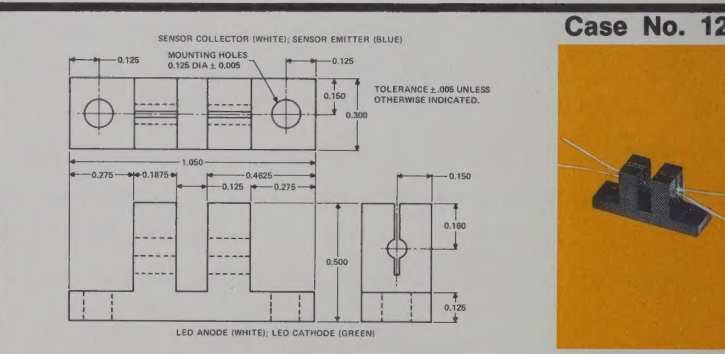
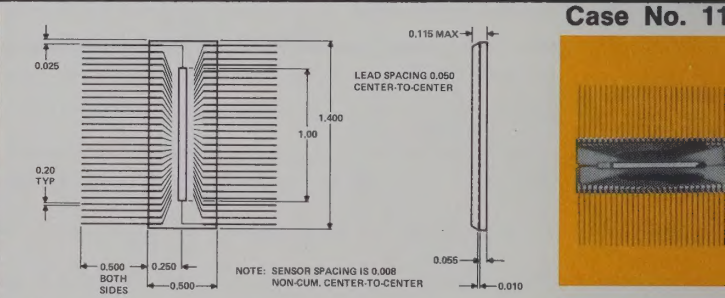
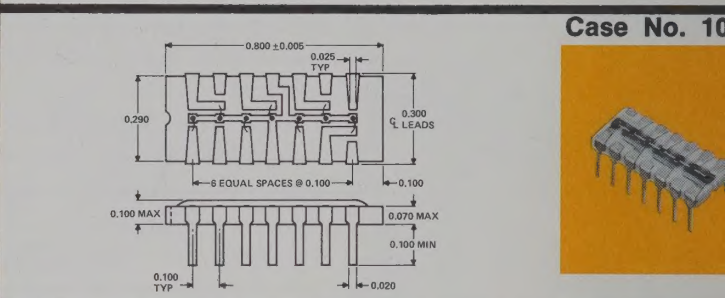
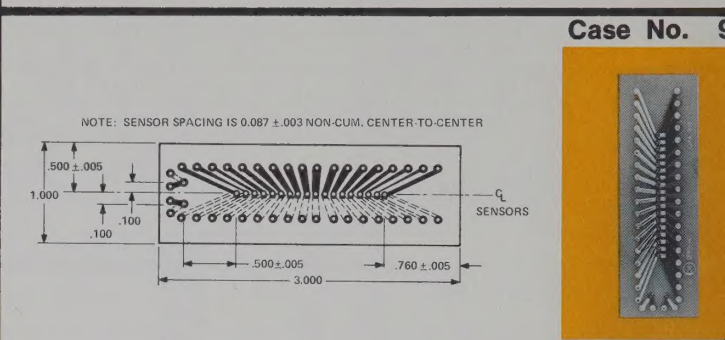
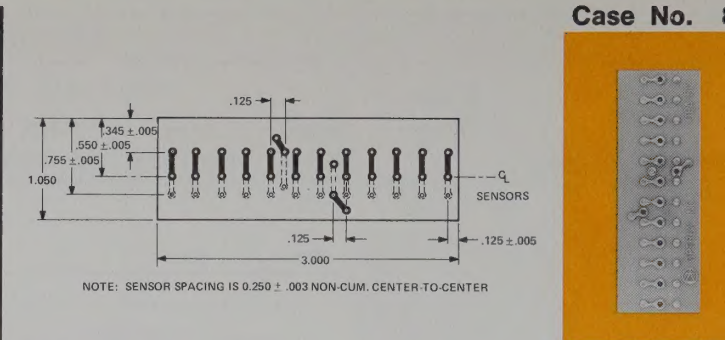
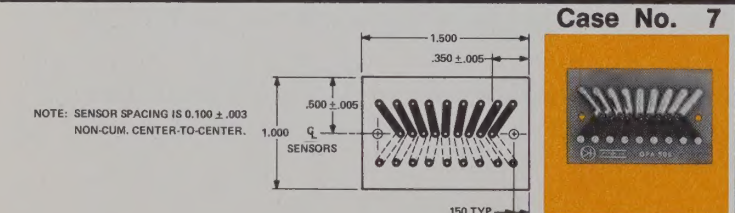
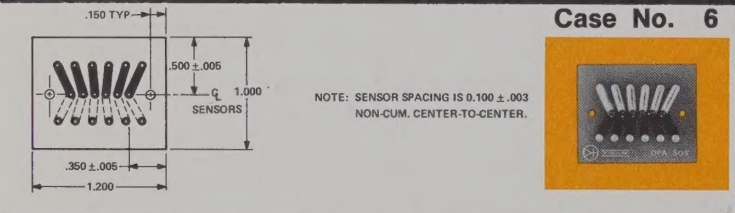
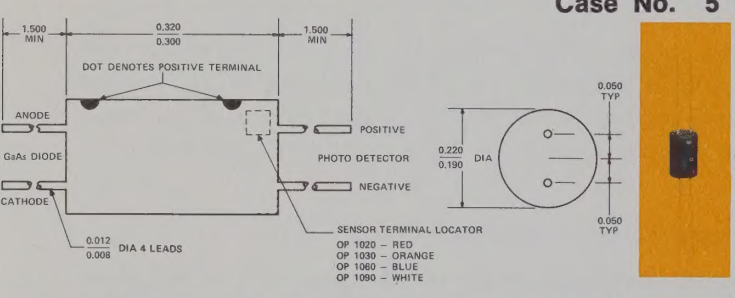
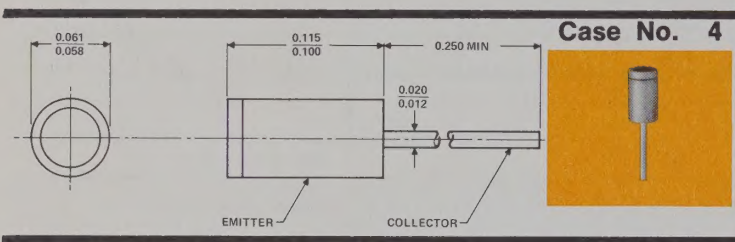
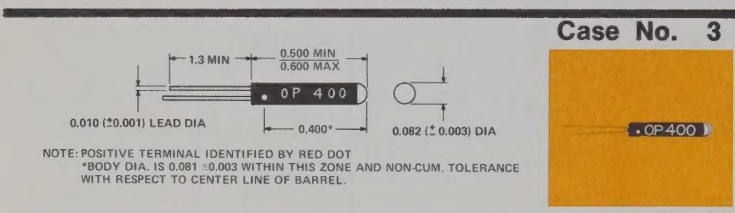
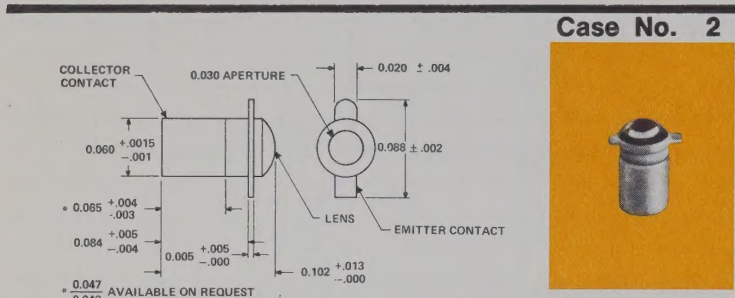
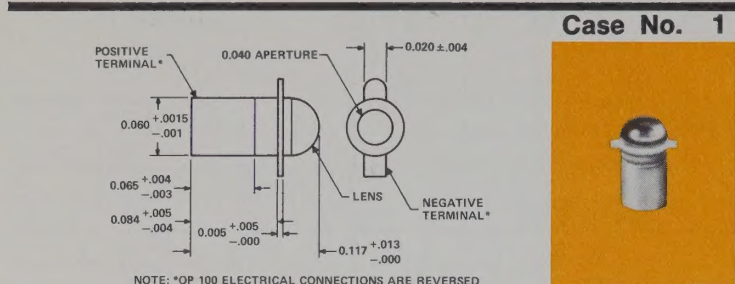
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Physical Description



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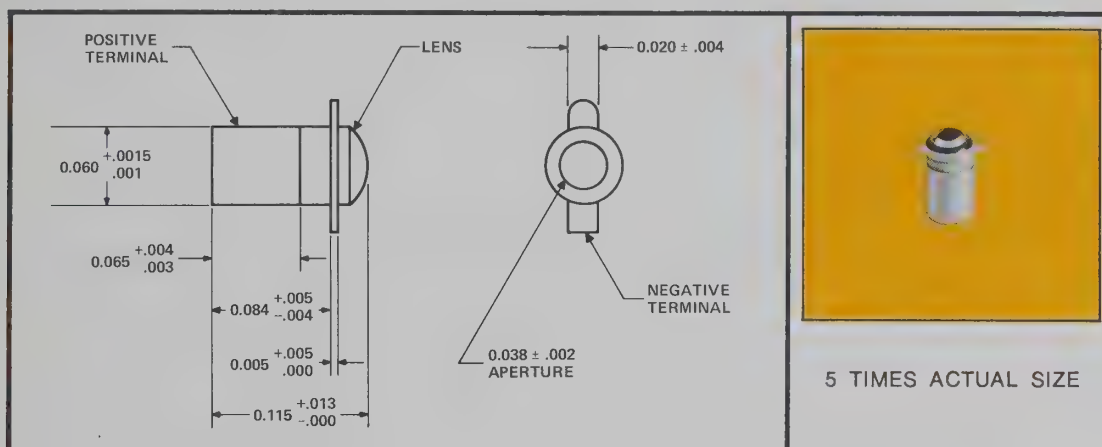
Types OP 123, OP 124 Gallium Arsenide Infrared Emitters

Bulletin No. 1016 August 1972

General Description

The OP 123 and OP 124 are microminiature infrared energy sources encased in a hermetic glass-to-metal seal package. These devices are spectrally matched to the popular OP 600 Series of light sensors. They can be mounted directly into printed circuit boards to meet custom requirements for light emitter arrays.

Physical Description



absolute maximum ratings (See Note 1)

Maximum Voltage

BV_R Reverse Voltage at 25°C Case Temperature 2 v

Maximum Forward Current at 25°C Case Temperature (See Note 2) 100 ma

Maximum Temperatures

Storage -65° to +150°C

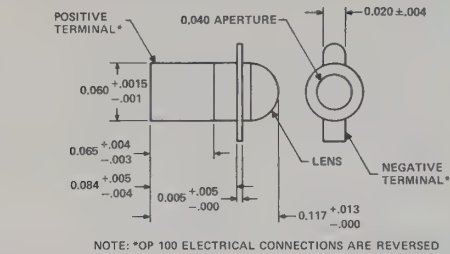
Operating -65° to +125°C

Soldering 240° for 3.0 minutes

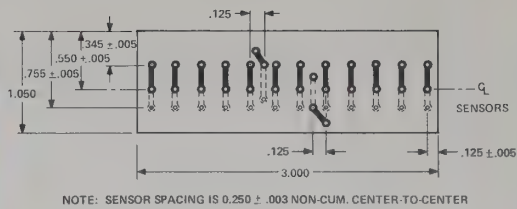
NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125° C case temperature at the rate of 1 ma/° C.

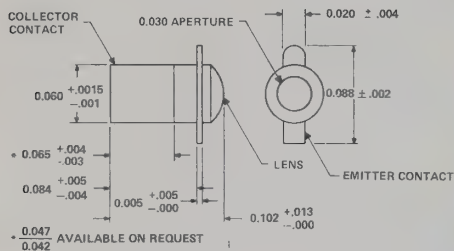
Physical Description



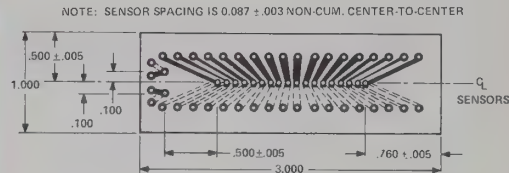
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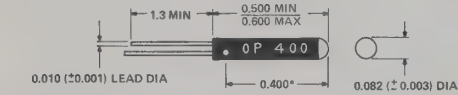
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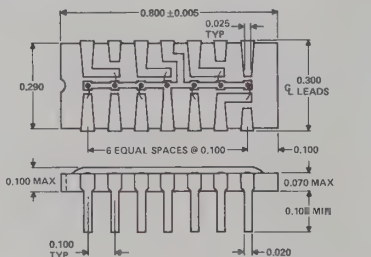
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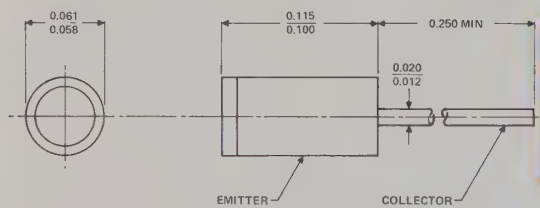
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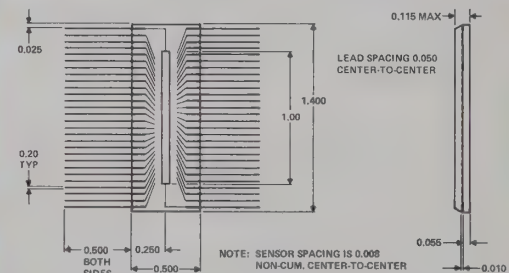
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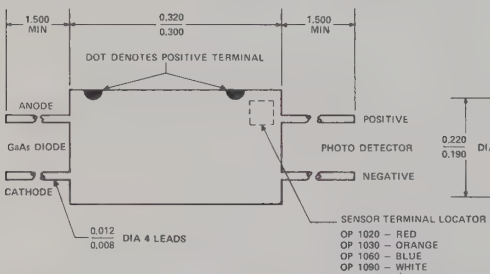
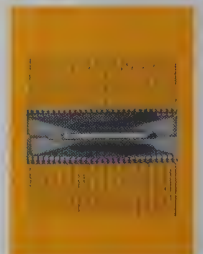
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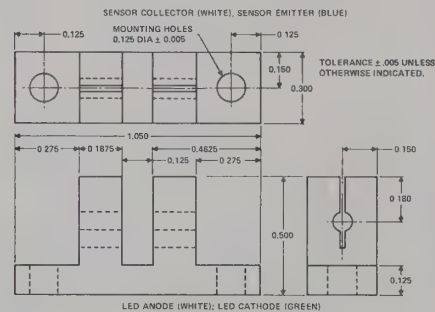
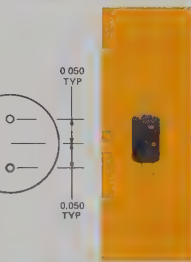
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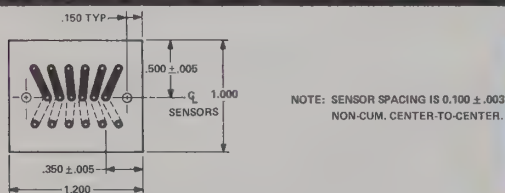
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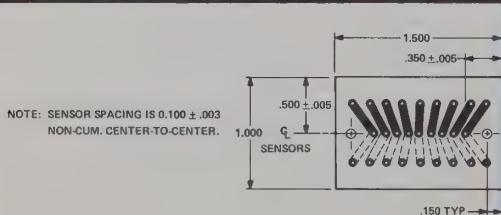
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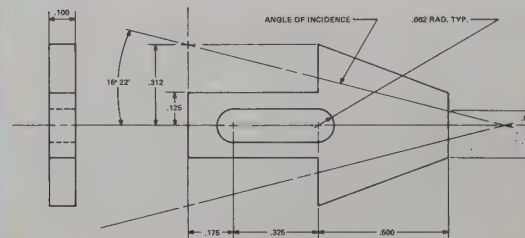
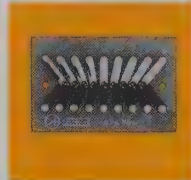
Case No. 12



Case No. 6



Case No. 7



Case No. 13





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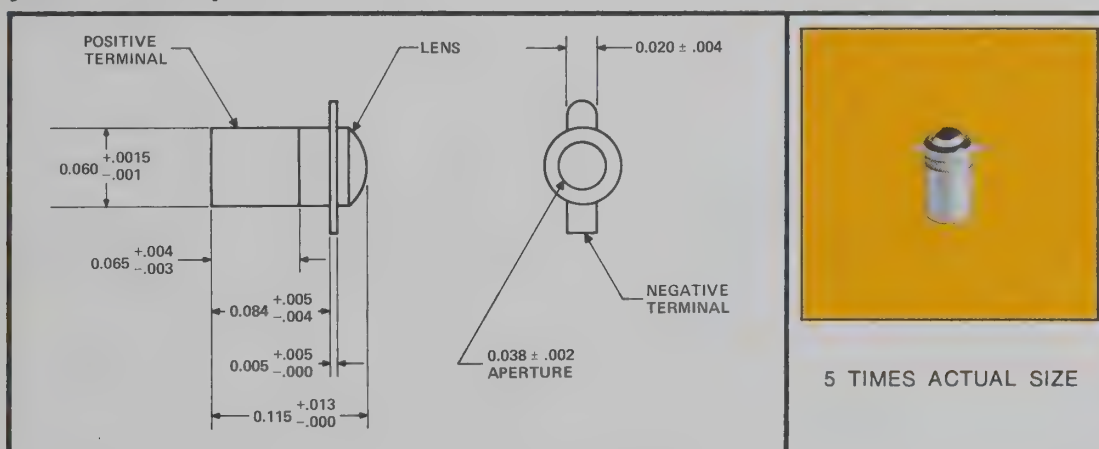
Types OP 123, OP 124 Gallium Arsenide Infrared Emitters

Bulletin No. 1016 August 1972

General Description

The OP 123 and OP 124 are microminiature infrared energy sources encased in a hermetic glass-to-metal seal package. These devices are spectrally matched to the popular OP 600 Series of light sensors. They can be mounted directly into printed circuit boards to meet custom requirements for light emitter arrays.

Physical Description



absolute maximum ratings (See Note 1)

Maximum Voltage

BV_R Reverse Voltage at 25°C Case Temperature 2 v

Maximum Forward Current at 25°C Case Temperature (See Note 2) 100 ma

Maximum Temperatures

Storage -65° to +150°C
Operating -65° to +125°C
Soldering 240° for 3.0 minutes

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125° C case temperature at the rate of 1 ma/° C.

Types OP 123, OP 124

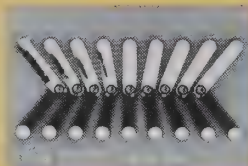
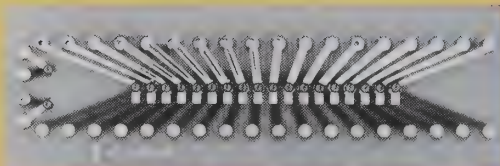
Gallium Arsenide Infrared Emitters

Bulletin No. 1016 August 1972

OPTRON, INC.

electrical characteristics at 25° C case temperature (unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS	OP 123			OP 124			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
P_o	Radiant Power Output		0.4			1.0			mw
λ_p	Wavelength at Peak Emission			0.93			0.93		μm
V_F	Static Forward Voltage				1.5			1.5	v
B	Spectral Bandwidth, FWHM	$I_F = 50 \text{ ma}$		500			500		$\text{\AA}$
θ	Emission Beam Angle at Half Power			35°			35°		



Complete Optical Array Production Capabilities

OPTRON can provide complete printed circuit board optical arrays, pre-assembled and pre-tested, in accordance with your specifications. Sensors selected for use in optical arrays can be supplied matched for improved performance. Contact your OPTRON sales representative or the factory direct for additional information.

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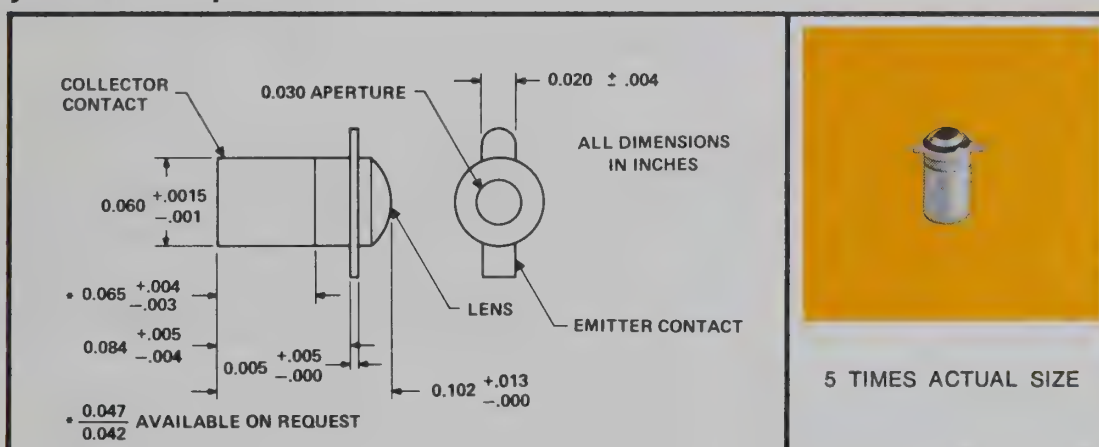
Type OP 300 Silicon Planar Darlington Light Sensor

Bulletin No. 1021 November 1972

General Description

The OP 300 is a microminiature Darlington photo-transistor encased in a hermetic glass-to-metal seal package. This extra sensitive device will satisfy applications associated with low light signal levels. The current output of the OP 300 with normal light input is sufficient to drive integrated circuit logic direct. The lens-device system minimizes sensor response to stray light. Optron's OP 123 gallium arsenide light emitting diode is more than adequate to drive this device to satisfactory light current output levels.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 1)

Maximum Voltages

BV _{CEO}	Collector-to-Emitter Voltage	15 v
BV _{ECO}	Emitter-to-Collector Voltage	5 v

Maximum Power Dissipation (See Note 2) 50 mw

Maximum Temperatures

Storage	-65° to +150°C
Operating	-65° to + 70°C
Soldering	240° for 3.0 minutes

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

Type OP 300

Silicon Planar Darlington Light Sensor

Bulletin No. 1021 November 1972

OPTRON, INC.

electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	15			v	$I_{CEO} = 100 \mu a$
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	5			v	$I_{ECO} = 100 \mu a$
$I_L(I_{CEO})$	Light Current	0.8	10		ma	$V_{CE} = 5.0 v, H = 1.0 \text{ mw/cm}^2$ (See Note 3)
$I_D(I_{CEO})$	Dark Current			1.0	μa	$V_{CE} = 10 v, H = 0$
$I_D(I_{CEO})$	Dark Current		100		μa	$V_{CE} = 10 v, H = 0$ $T_A = 100^\circ C$
$V_{CE(sat)}$	Collector-to-Emitter Saturation Voltage		1.0		v	$I_L = 2.0 \text{ ma}, H = 1.0 \text{ mw/cm}^2$ (See Note 3)
t_r	Light Current Rise Time		50		μsec	$V_{CC} = 5.0 v, I_L = 4.0 \text{ ma}$ $R_L = 100\Omega$ (See Note 4 & Fig. 1)
t_f	Light Current Fall Time		50		μsec	$V_{CC} = 5.0 v, I_L = 4.0 \text{ ma}$ $R_L = 100\Omega$ (See Note 4 & Fig. 1)

NOTE 3. Irradiance (H) is the radiant power per unit area incident upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at a 2870°K color temperature.

NOTE 4. Input irradiance (H) is supplied by a pulsed gallium arsenide light emitting diode (LED). The output of the LED is adjusted until I_L is 4.0 ma.

switching time test circuit

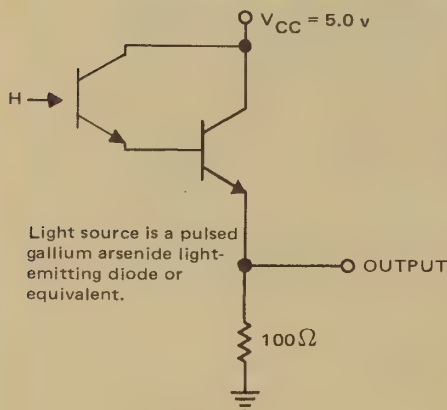
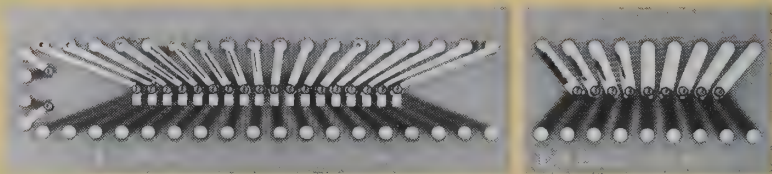


FIGURE 1

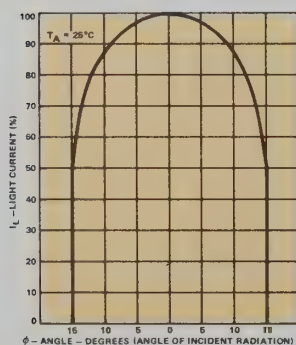


Complete Optical Array Production Capabilities

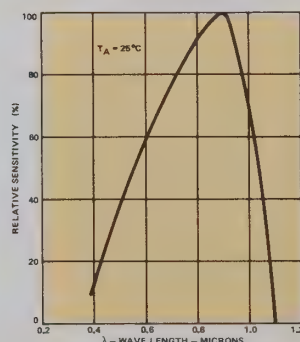
OPTRON can provide complete printed circuit board optical arrays, pre-assembled and pre-tested, in accordance with your specifications. Sensors selected for use in optical arrays can be supplied matched for improved performance. Contact your OPTRON sales representative or the factory direct for additional information.

Typical Design Graphs

TYPICAL ANGULAR RESPONSE (% OUTPUT NORMALIZED)



SILICON SPECTRAL RESPONSE



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Types OPA 505 - OPA 505A — OPA 508 - OPA 508A N-P-N Planar Light Sensor Arrays

Bulletin No. 1015 August 1972

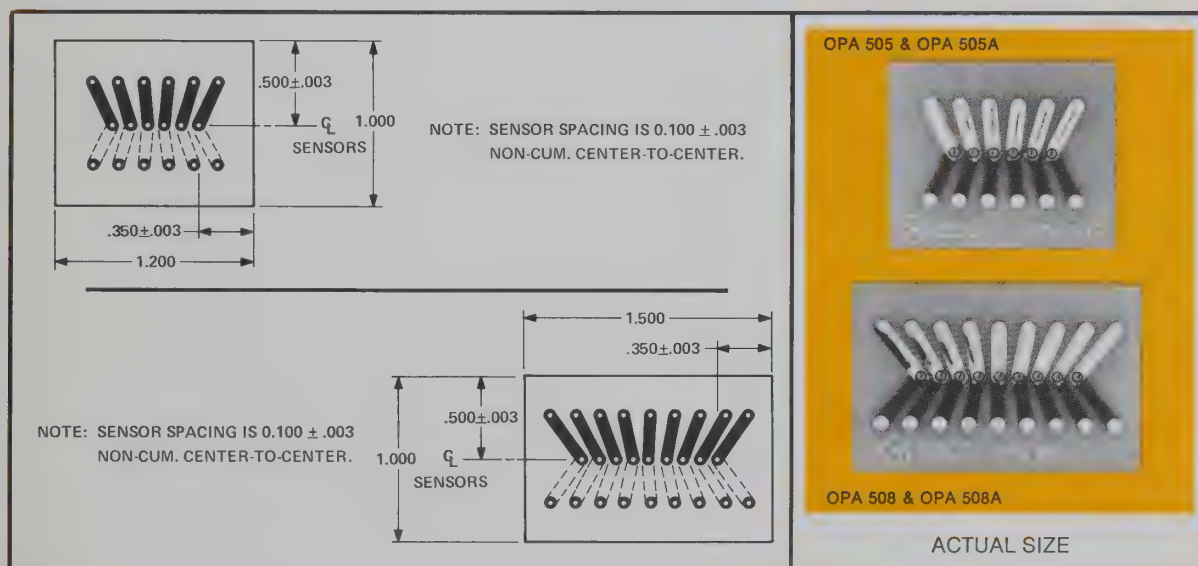
General Description

These light sensor arrays will satisfy the sensing requirements for punched tape readers manufactured for the electronic data processing industry. The basic light sensor is the Optron OP 600 type device.

All arrays are supplied as fully tested assemblies. The OPA 505A and OPA 508A are intended for use in applications where tightened limits on light current matching specifications are required.

For custom designs or special testing other than that described here, please contact your nearest Optron representative or the factory direct.

Physical Description



Electrical Description (See Note 1)

absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 2)

Maximum Voltages

BV_{CEO} Collector-to-Emitter Voltage 25 v

BV_{ECO} Emitter-to-Collector Voltage 5 v

Maximum Power Dissipation/Sensor (See Note 3) 50 mw

Maximum Temperatures

Storage -40° to +100°C

Operating -40° to + 85°C

Soldering (See Note 4)

NOTE 1. All electrical characteristics are similar to the OP 600 type sensors unless otherwise specified. For additional technical design information, see Optron Bulletin No. 1004.

NOTE 2. Ratings at which device performance may be impaired if exceeded.

NOTE 3. Power dissipation rating is with sensor not mounted in array and in free-air at 25°C.

NOTE 4. Individual sensors are rated for soldering at 240°C for 30 seconds. Precaution should be taken when connecting wiring to array to avoid melting solder around sensors, if possible.

Types OPA 505-OPA 505A — OPA 508-OPA 508A N-P-N Planar Light Sensor Arrays

OPTRON, INC.

Bulletin No. 1015 August 1972

electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	25			v	$I_{CEO} = 100 \mu a$
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	5			v	$I_{ECO} = 100 \mu a$
$I_L (I_{CEO})$	Light Current	0.8	3.0		ma	$V_{CE} = 5.0 v$, $H = 20 \text{ mw/cm}^2$ (See Note 5)
$I_D (I_{CEO})$	Dark Current			0.1	μa	$V_{CE} = 10 v, H = 0$
$I_D (I_{CEO})$	Dark Current		8.0		μa	$V_{CE} = 10 v, H = 0$, $T_A = 85^\circ C$
I_{Lmin}/I_{Lmax}	Matching Factor (See Note 6)	0.5 0.75		1.0 1.0		$V_{CE} = 5.0 v$, $H = 20 \text{ mw/cm}^2$ $V_{CE} = 5.0 v$, $H = 20 \text{ mw/cm}^2$
t_r	Light Current Rise Time		2.5		μsec	$V_{CC} = 5.0 v$, $I_L = 0.8 \text{ ma}$ $R_L = 1K\Omega$ (See Note 7 & Fig. 1)
t_f	Light Current Fall Time		2.5		μsec	$V_{CC} = 5.0 v$, $I_L = 0.8 \text{ ma}$ $R_L = 1K\Omega$ (See Note 7 & Fig. 1)
$V_{CE(sat)}$	Collector-to-Emitter Saturation Voltage			0.4	v	$I_L = 0.4 \text{ ma}$, $H = 20 \text{ mw/cm}^2$ (See Note 5)

switching time test circuit

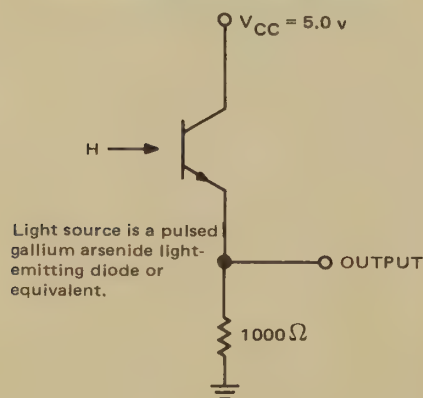


FIGURE 1

NOTE 5. Irradiance (H) is the radiant power per unit area upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at a 2870°K color temperature (CT).

NOTE 6. Matching factor is determined by the ratio of the least sensitive sensor to the most sensitive. The 0.75 to 1.0 limit applies to the OPA 505A and OPA 508A only.

NOTE 7. Input Irradiance H is supplied by a pulsed gallium arsenide light emitting diode (LED) or equivalent. The output of the LED is adjusted until I_L is 0.8 ma.

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OPTRON, INC.

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214/242-6571

Types OPA 512 - OPA 512A — OPA 518 - OPA 518A Optoelectronic Arrays for Card Readers

Bulletin No. 1014 August 1972

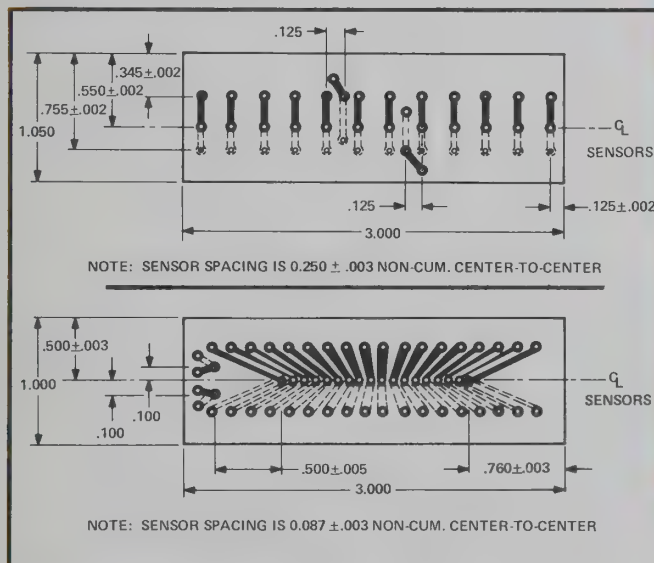
General Description

These light sensor arrays will satisfy the sensing requirements for punched card readers manufactured for the electronic data processing industry. The OPA 518 and OPA 518A arrays are intended to meet the reading requirements of the new miniature punched card format. The basic light sensor is the Optron OP 600 type device.

All arrays are supplied as fully tested assemblies. The OPA 512A and OPA 518A are intended for use in applications where tightened limits on light current matching specifications are required.

For custom designs or special testing other than that described here, please contact your nearest Optron representative or the factory direct.

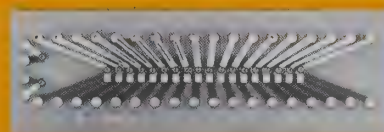
Physical Description



OPA 512 & OPA 512A



OPA 518 & OPA 518A



2/3 ACTUAL SIZE

Electrical Description (See Note 1)

absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 2)

Maximum Voltages

BV_{CEO} Collector-to-Emitter Voltage 25 v

BV_{ECO} Emitter-to-Collector Voltage 5 v

Maximum Power Dissipation/Sensor (See Note 3) 50 mw

Maximum Temperatures

Storage -40° to +100°C

Operating -40° to + 85°C

Soldering (See Note 4)

NOTE 1. All electrical characteristics are similar to the OP 600 type sensors unless otherwise specified. For additional technical design information, see Optron Bulletin No. 1004.

NOTE 2. Ratings at which device performance may be impaired if exceeded.

NOTE 3. Power dissipation rating is with sensor not mounted in array and in free-air at 25°C.

NOTE 4. Individual sensors are rated for soldering at 240°C for 30 seconds. Precaution should be taken when connecting wiring to array to avoid melting solder around sensors, if possible.

Types OPA 512 - OPA 512A — OPA 518 - OPA 518A

Optoelectronic Arrays for Card Readers

Bulletin No. 1014 August 1972

OPTRON, INC.

electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	25			v	$I_{CEO} = 100 \mu a$
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	5			v	$I_{ECO} = 100 \mu a$
$I_L (I_{CEO})$	Light Current	0.8	3.0		ma	$V_{CE} = 5.0 v$, $H = 20 mw/cm^2$ (See Note 5)
$I_D (I_{CEO})$	Dark Current			0.1	μa	$V_{CE} = 10 v, H = 0$
$I_D (I_{CEO})$	Dark Current		8.0		μa	$V_{CE} = 10 v, H = 0$, $T_A = 85^\circ C$
I_{Lmin}/I_{Lmax}	Matching Factor (See Note 6)	0.5 0.75		1.0 1.0		$V_{CE} = 5.0 v$, $H = 20 mw/cm^2$ $V_{CE} = 5.0 v$, $H = 20 mw/cm^2$
t_r	Light Current Rise Time		2.5		μsec	$V_{CC} = 5.0 v$, $I_L = 0.8 ma$ $R_L = 1K\Omega$ (See Note 7 & Fig. 1)
t_f	Light Current Fall Time		2.5		μsec	$V_{CC} = 5.0 v$, $I_L = 0.8 ma$ $R_L = 1K\Omega$ (See Note 7 & Fig. 1)
$V_{CE(sat)}$	Collector-to-Emitter Saturation Voltage			0.4	v	$I_L = 0.4 ma$, $H = 20 mw/cm^2$ (See Note 5)

switching time test circuit

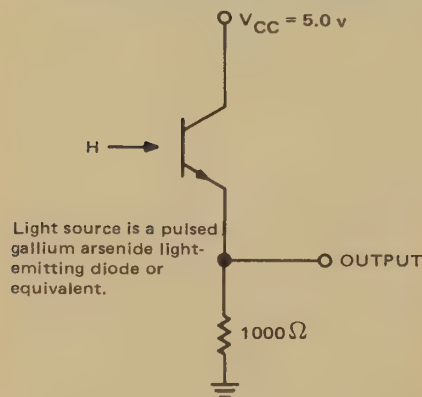


FIGURE 1

NOTE 5. Irradiance (H) is the radiant power per unit area upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at a 2870°K color temperature (CT).

NOTE 6. Matching factor is determined by the ratio of the least sensitive sensor to the most sensitive. The 0.75 to 1.0 limit applies to the OPA 512A and OPA 518A only.

NOTE 7. Input Irradiance H is supplied by a pulsed gallium arsenide light emitting diode (LED) or equivalent. The output of the LED is adjusted until I_L is 0.8 ma.

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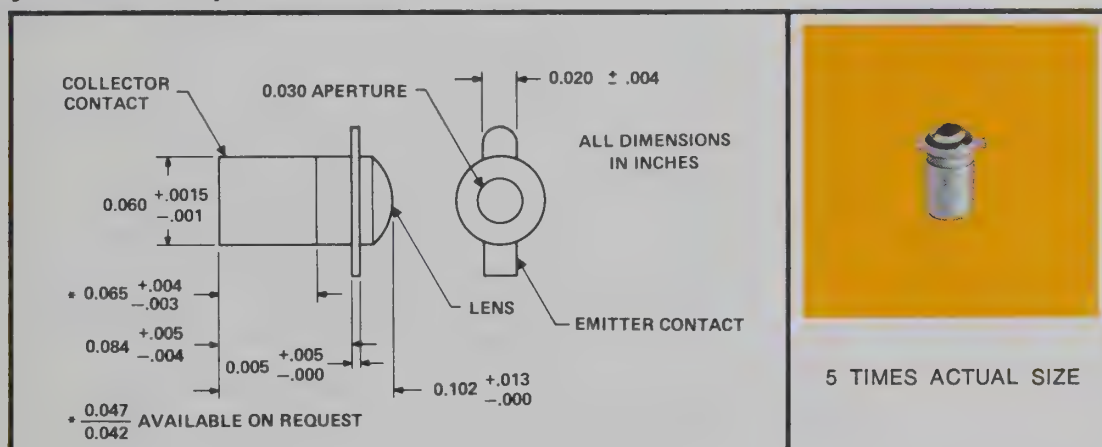
Type OP 600 N-P-N Silicon Planar Light Sensor

Bulletin No. 1022 November 1972

General Description

The OP 600 is a microminiature photo-transistor encased in a hermetic glass-to-metal seal package. This two terminal device is intended to be mounted directly to a printed circuit board. The lens-device system minimizes sensor response to stray light.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 1)

Maximum Voltages

BV _{CEO}	Collector-to-Emitter Voltage	50 v
BV _{ECO}	Emitter-to-Collector Voltage	7 v

Maximum Power Dissipation (See Note 2) 50 mw

Maximum Temperatures

Storage	-65° to +150°C
Operating	-65° to +125°C
Soldering	240° for 3.0 minutes

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

Type OP 600

N-P-N Silicon Planar Light Sensor

Bulletin No. 1022 November 1972

OPTRON, INC.

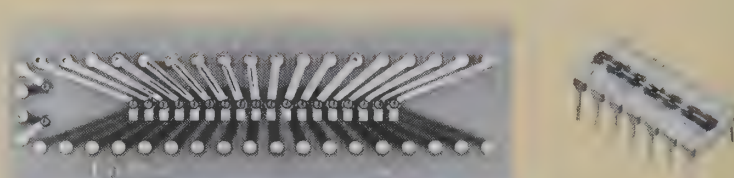
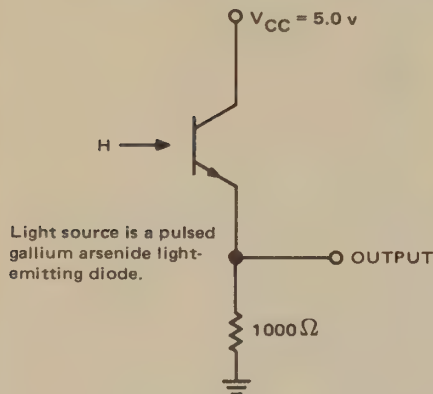
electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	50			v	$I_{CEO} = 100 \mu a$
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	7			v	$I_{ECO} = 100 \mu a$
$I_L(I_{CEO})$	Light Current	0.8			ma	$V_{CE} = 5.0 v, H = 20 \text{ mw/cm}^2$ (See Note 3)
$I_D(I_{CEO})$	Dark Current			25	na	$V_{CE} = 30 v, H = 0$
$I_D(I_{CEO})$	Dark Current		10		μa	$V_{CE} = 30 v, H = 0$ $T_A = 100^\circ C$
$V_{CE(sat)}$	Collector-to-Emitter Saturation Voltage		0.2		v	$I_L = 0.4 \text{ ma}, H = 20 \text{ mw/cm}^2$ (See Note 3)
t_r	Light Current Rise Time		2.5		μsec	$V_{CC} = 5.0 v, I_L = 0.8 \text{ ma}$ $R_L = 1000 \Omega$ (See Note 4 & Fig. 1)
t_f	Light Current Fall Time		2.5		μsec	$V_{CC} = 5.0 v, I_L = 0.8 \text{ ma}$ $R_L = 1000 \Omega$ (See Note 4 & Fig. 1)

NOTE 3. Irradiance (H) is the radiant power per unit area incident upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at a 2870°K color temperature.

NOTE 4. Input irradiance (H) is supplied by a pulsed gallium arsenide light emitting diode (LED). The output of the LED is adjusted until I_L is 0.8 ma.

switching time test circuit

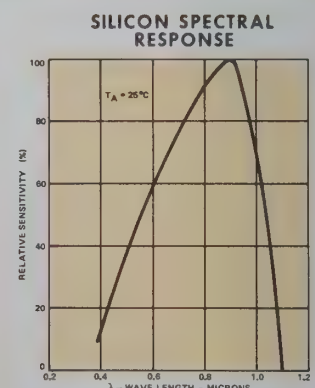
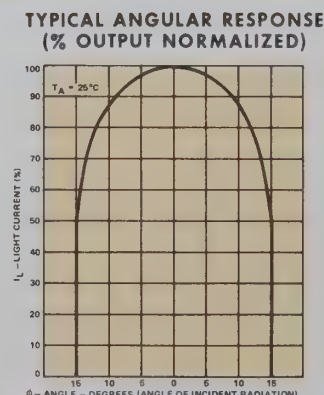
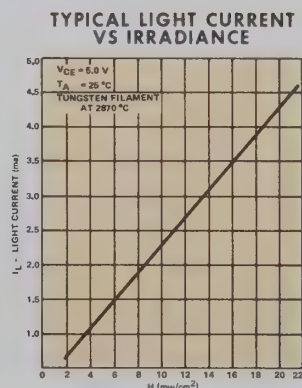
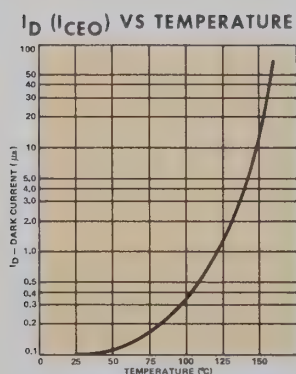


Complete Optoelectronic Production Capabilities

OPTRON can provide complete discrete, hybrid or monolithic optical arrays, pre-assembled and pre-tested, to your specifications. In addition, OPTRON is experienced and capable of working on your most stringent *custom* requirements or interface problems. An OPTRON-assembled functional module offers you significant system-cost and performance advantages. Contact your OPTRON sales representative or the factory direct for additional information.

FIGURE 1

Typical Design Graphs



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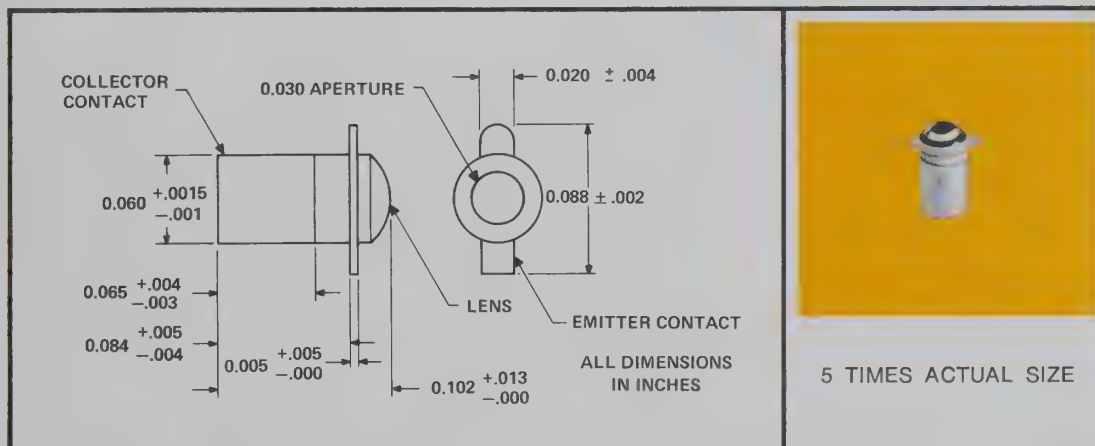
Types OP 601-605, OP 641-645 N-P-N Silicon Planar Light Sensor Series

Bulletin No. 1023 December 1972

General Description

This series of devices will satisfy the requirements for critical applications where predictable light current matching and tracking capabilities are needed to meet varying light intensity and color temperature conditions. These two-terminal devices are hermetically encased in a microminiature metal-ceramic package for easy mounting directly to printed circuit boards. The glass lens-device system minimizes sensor response to stray light.

Physical Description



absolute maximum ratings at 25°C free-air temperature

(all devices unless otherwise specified — see Note 1)

Maximum Voltages													OP 601-605	OP 641-645							
BV _{CEO}	Collector-to-Emitter	.	.	.	.	.	.	.	.	.	.	.	50 v	25 v							
BV _{ECO}	Emitter-to-Collector	.	.	.	.	.	.	.	.	.	.	.	7 v	5 v							
Maximum Power Dissipation (See Note 2)													.	.	.	.	.	.	.	.	50 mw
Maximum Temperatures																					
Storage	.	.	.	.	.	.	.	.	.	.	.	.	.	- 65° to +150°C							
Operating	.	.	.	.	.	.	.	.	.	.	.	.	.	- 65° to +125°C							
Soldering	.	.	.	.	.	.	.	.	.	.	.	.	.	+240°C for 3.0 minutes							

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to +125°C free-air temperature at the rate of 0.5 mw/°C.

Types OP 601-605, OP 641-645

N-P-N Silicon Planar Light Sensor Series

OPTRON, INC.

Bulletin No. 1023 December 1972

electrical characteristics at 25°C free-air temperature

SYMBOL	PARAMETER	TYPE	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	OP 601-605	50			v	$I_C = 100 \mu a$ $H = 0$
		OP 641-645	25			v	
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	OP 601-605	7			v	$I_E = 100 \mu a$ $H = 0$
		OP 641-645	5			v	
I_D	Dark Current	OP 601-605			25	na	$V_{CE} = 30 v$ $H = 0$
		OP 641-645			100	na	$V_{CE} = 10 v$ $H = 0$
I_L	Light Current	OP 601-641	0.5		3.0	ma	$V_{CE} = 5 v$ $H = 20 \text{ mw/cm}^2$ (See Note 3)
		OP 602-642	2		5	ma	
		OP 603-643	4		8	ma	
		OP 604-644	7		22	ma	
		OP 605-645	15			ma	
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	All Devices			0.4	v	$I_C = 0.4 \text{ ma}$ $H = 20 \text{ mw/cm}^2$

typical switching characteristics at 25°C case temperature (See Note 4 and Figure 1)

SYMBOL	PARAMETER	OP 601-641	OP 602-642	OP 603-643	OP 604-644	OP 605-645	UNIT	TEST CONDITIONS
t_r	Rise Time	2	2	2.5	2.5	3.0	μs	$V_{CC} = 5 v$ $I_L = 0.8 \text{ ma}$
t_f	Fall Time	2	3.5	5.0	7.0	15	μs	$R_L = 1 K\Omega$

switching time test circuit

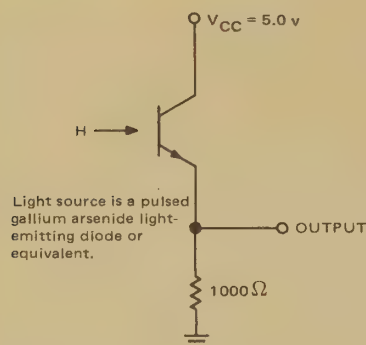


FIGURE 1

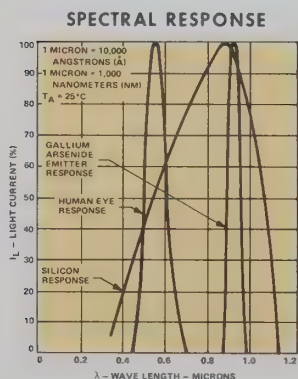
NOTE 3. Irradiance (H) is the radiant power per unit area incident upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at 2870°K color temperature (CT).

NOTE 4. Input irradiance (H) is supplied by a pulsed gallium arsenide light emitting diode (LED) or equivalent. The output of the LED is adjusted until I_L is 0.8 ma.

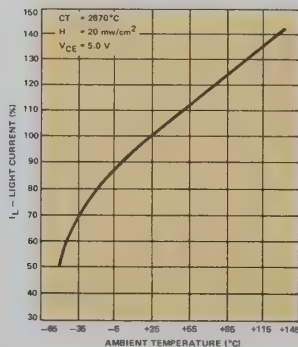
Complete Optoelectronic Production Capabilities

OPTRON can provide complete discrete, hybrid or monolithic optical arrays, pre-assembled and pre-tested, to your specifications. In addition, OPTRON is experienced and capable of working on your most stringent *custom* requirements or interface problems. An OPTRON-assembled functional module offers you significant system-cost and performance advantages. Contact your OPTRON sales representative or the factory direct for additional information.

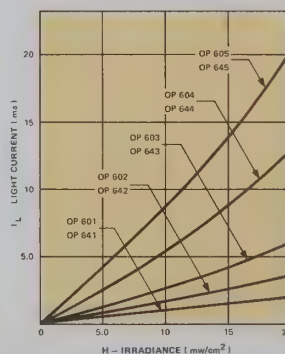
Typical Design Graphs



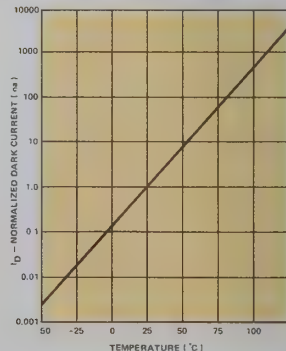
TYPICAL LIGHT CURRENT VS AMBIENT TEMPERATURE (% OUTPUT NORMALIZED)



TYPICAL LIGHT CURRENT VS IRRADIANCE



NORMALIZED DARK CURRENT VS TEMPERATURE



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Type OP 666 Serial No. _____

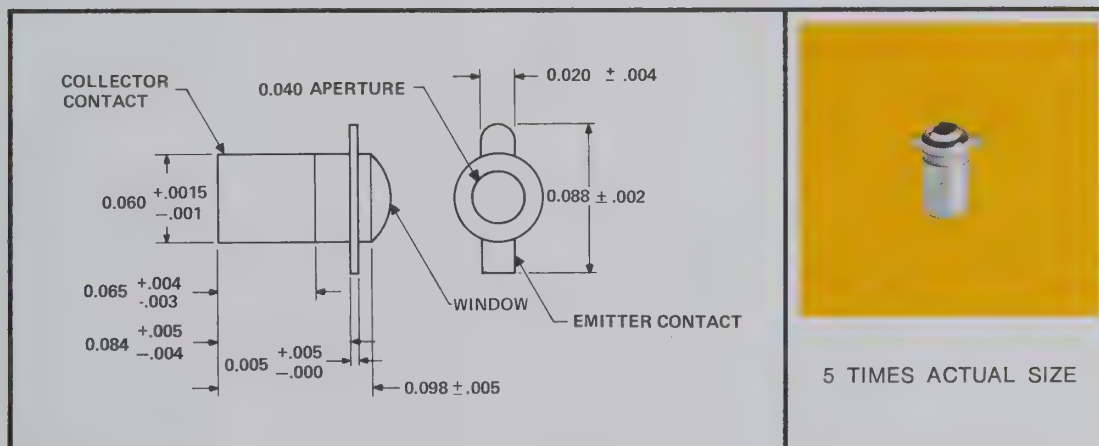
Photometric Light Standard

Bulletin No. 1020 September 1972

General Description

The OP 666 is a microminiature photo-transistor encased in a hermetic glass-to-metal seal package. This two terminal device is intended to be mounted directly to a printed circuit board. This device has been calibrated for use as a photometric standard.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 1)

Maximum Voltages

BV_{CEO}	Collector-to-Emitter Voltage	25 v
BV_{ECO}	Emitter-to-Collector Voltage	5 v

Maximum Power Dissipation (See Note 2) 50 mw

Maximum Temperatures

Storage	-65° to +150°C
Operating	-65° to +125°C
Soldering	240°C for 3.0 minutes

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

Type OP 666 Serial No. _____

Photometric Light Standard

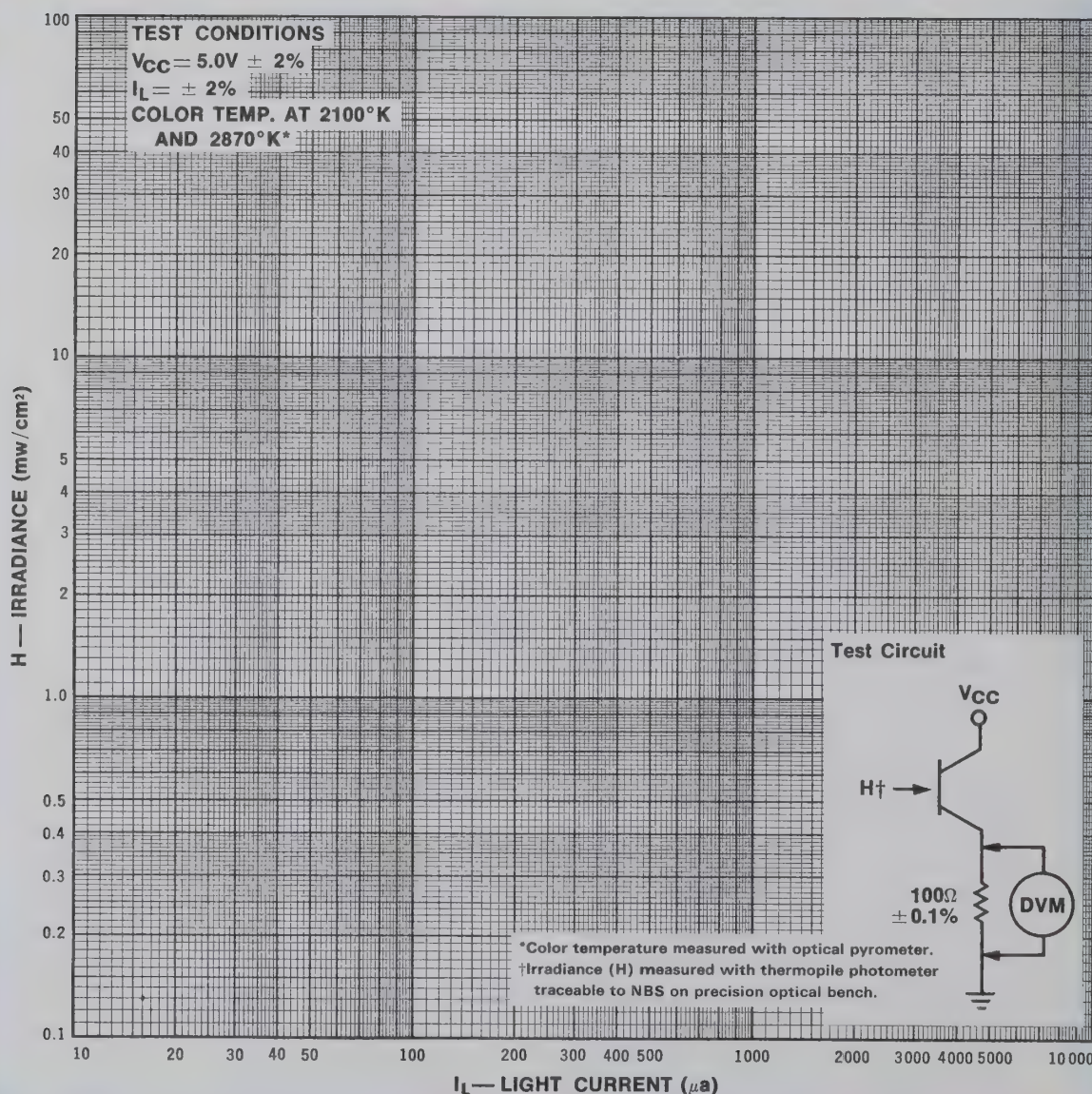
Bulletin No. 1020 September 1972

OPTRON, INC.

electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	25			v	$I_{CEO} = 100 \mu a$
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	5			v	$I_{ECO} = 100 \mu a$
$I_L(I_{CEO})$	Light Current	—			ma	$V_{CE} = 5.0 v, H = 20 \text{ mw/cm}^2$
$I_D(I_{CEO})$	Dark Current			.100	na	$V_{CE} = 10 v, H = 0$
$I_D(I_{CEO})$	Dark Current		10		μa	$V_{CE} = 10 v, H = 0$ $T_A = 100^\circ C$

Calibration Curve



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 CLEVELAND, OHIO 44143
 PHONE: (216) 461-8333


OPTRON, INC.
 1201 Tappan Circle
 Carrollton, Texas 75006
 214/242-6571

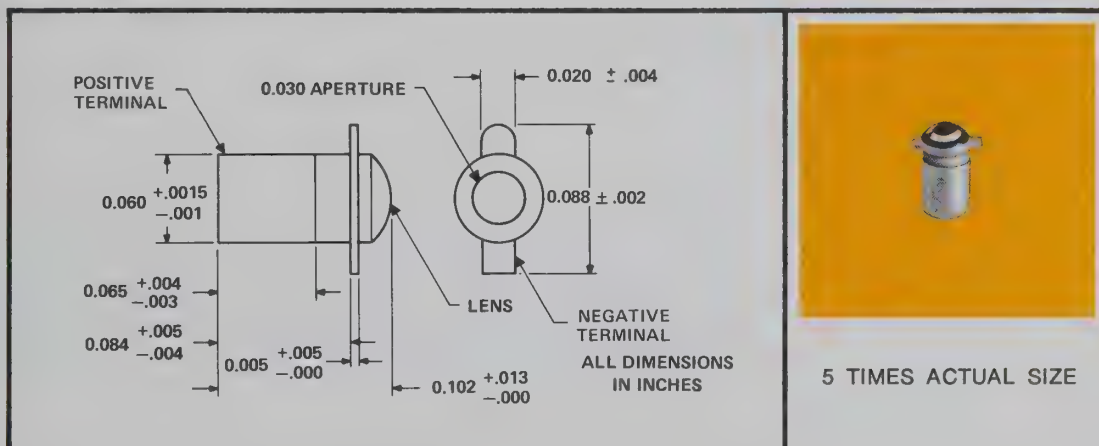
Type OP 900 P-N Silicon Planar Light Sensor

Bulletin No. DS 1007 September 1969

General Description

The OP 900 is a microminiature photo-diode encased in a hermetic glass-to-metal seal package. This two-terminal device is intended to be mounted directly to a printed circuit board. The lens-device system minimizes sensor response to stray light. This device is intended for use in applications requiring fast switching times.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 1)

Maximum Voltages	
BV _R Reverse Voltage	100 v
Maximum Power Dissipation (See Note 2)	
	50 mw
Maximum Temperatures	
Storage	-65° to +150°C
Operating	-65° to +125°C
Soldering	240° C for 3.0 minutes

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

Type OP 900

P-N Silicon Planar Light Sensor

Bulletin No. DS 1007 September 1969

OPTRON, INC.

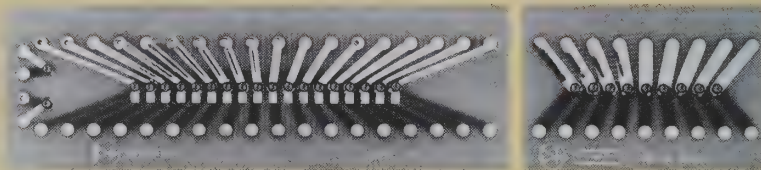
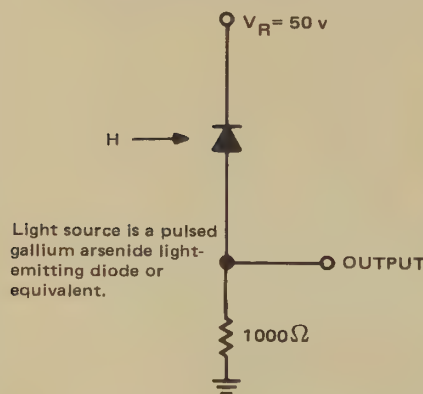
electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_R	Reverse Voltage Breakdown	100	150		v	$I_R = 100 \mu a$
I_L	Light Current	8	14		μa	$V_R = 50 v, H = 20 \text{ mw/cm}^2$ (See Note 3)
I_D	Dark Current			8	na	$V_R = 50 v, H = 0$
I_D	Dark Current		1.0		μa	$V_R = 50 v, H = 0$ $T_A = 100^\circ C$
t_r	Light Current Rise Time		100		nsec	$V_R = 50 v, I_L = 8 \mu a$ $R_L = 1000 \Omega$ (See Note 4 & Fig. 1)
t_f	Light Current Fall Time		100		nsec	$V_R = 50 v, I_L = 8 \mu a$ $R_L = 1000 \Omega$ (See Note 4 & Fig. 1)

NOTE 3. Irradiance (H) is the radiant power per unit area incident upon a surface. For this measurement the source is an unfiltered tungsten linear filament bulb operating at a 2870°K color temperature (CT).

NOTE 4. Input irradiance (H) is supplied by a pulsed gallium arsenide light emitting diode (LED). The output of the LED is adjusted until I_L is 8.0 μa .

switching time test circuit



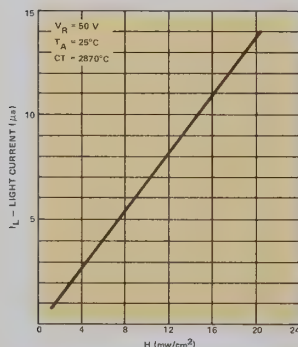
Complete Optical Array Production Capabilities

OPTRON can provide complete printed circuit board optical arrays, pre-assembled and pre-tested, in accordance with your specifications. Sensors selected for use in optical arrays can be supplied matched for improved performance. Contact your OPTRON sales representative or the factory direct for additional information.

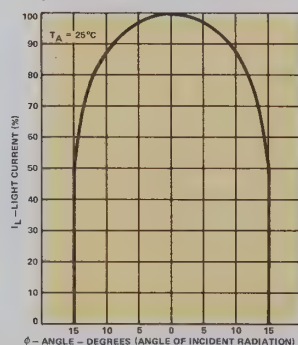
FIGURE 1

Typical Design Graphs

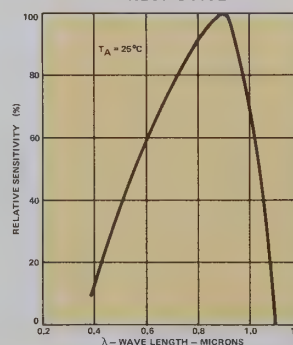
TYPICAL LIGHT CURRENT VS IRRADIANCE



TYPICAL ANGULAR RESPONSE (% OUTPUT NORMALIZED)



SILICON SPECTRAL RESPONSE



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IN ORDER TO IMPROVE DESIGN
AND TO SUPPLY
THE BEST PRODUCT POSSIBLE.



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Types OP 1020, OP 1030, OP 1060, OP 1090 Gallium Arsenide Diode — Silicon Photodetector Couplers

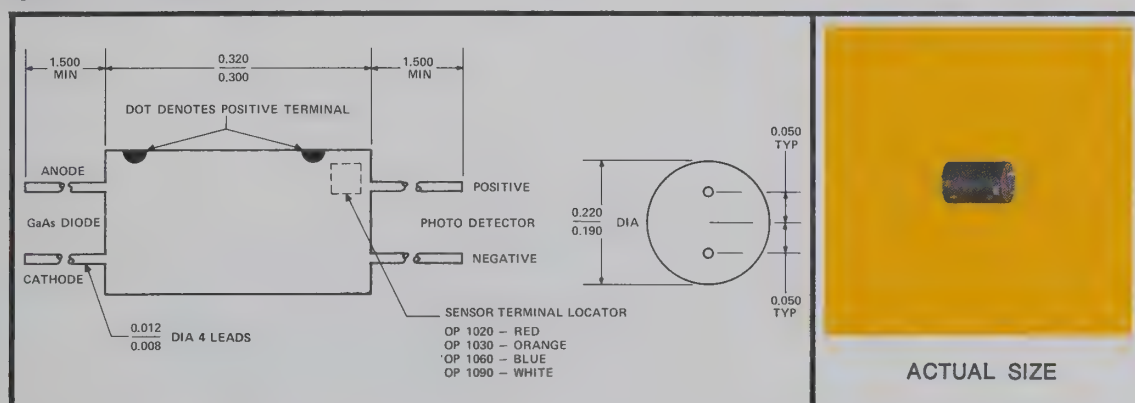
Bulletin No. 1013 November 1970

General Description

This series of device assemblies offers the designer a wide range of choices in specifying the optimum device for data transmission applications. These isolators provide a simple and economical method of eliminating "ground loops" when communicating between electronic equipment physically separated by long distances. The effect of transformer isolation at 0 cps or dc is achieved.

Isolation breakdown rating between input and output is 3000 volts minimum.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — see Note 1)

	OP 1020	OP 1030	OP 1060	OP 1090
Detector Only				
Maximum Voltages				
BV _{CEO} Collector-to-Emitter	40 v	15 v	40 v	
BV _{ECO} Emitter-to-Collector	5 v	5 v	5 v	
BV _R Reverse Voltage				100 v
Maximum Power Dissipation (See Note 2) . .	50 mw	50 mw	50 mw	50 mw
Input Diode Only				
BV _R Maximum Reverse Voltage	3 v	3 v	3 v	3 v
Maximum Power Dissipation (See Note 2) . .	50 mw	50 mw	50 mw	50 mw
Detector and Input Diode				
Maximum Temperatures				
Storage	-65°C to +150°C	+150°C	+150°C	+150°C
Operating	-65°C to +125°C	+85°C	+125°C	+125°C
Soldering (See Note 3)		+240°C for 3.0 minutes		

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

NOTE 3. Leads only. All devices.

Types OP 1020, OP 1030, OP 1060, OP 1090

Gallium Arsenide Diode— Silicon Photodetector Couplers

OPTRON, INC.

Bulletin No. 1013 November 1970

input diode electrical characteristics at 25°C free-air temperature (all devices unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
BV_R	Reverse Breakdown Voltage	$I_R = 100 \mu a$	3			v
V_F	Static Forward Voltage	$I_F = 50 ma$			1.5	v

detector electrical characteristics at 25°C free-air temperature (all devices unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
			OP 1020			OP 1030			OP 1060			OP 1090			
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	$I_{CEO} = 100 \mu a$	40			15			40						v
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	$I_{ECO} = 100 \mu a$	5			5			5						v
B_{VR}	Reverse Voltage Breakdown	$I_R = 100 \mu a$										100			v
I_O	Output Current	$V_R = 5.0 v$, Input Diode $I_F = 40 ma$	0.1						0.25			.002			ma
I_O	Output Current	$V_R = 5.0 v$, Input Diode $I_F = 10 ma$				4									ma
I_{off}	Output Leakage Current	$V_R = 30 v$, $I_F = 0$, (H=0)			25					25				10	na
I_{off}	Output Leakage Current	$V_R = 10 v$, $I_F = 0$, (H=0)					250								na
t_r	Output Current Rise Time	$V_{CC} = 5.0 v$, $I_f = 5 ma$ (max 50% duty cycle) $R_L = 1000 \Omega$ (See Fig. 1)	1.0			50			3.5			.030			μsec
t_f	Output Current Fall Time	$V_{CC} = 5.0 v$, $I_f = 5 ma$ (max 50% duty cycle) $R_L = 1000 \Omega$ (See Fig. 1)	2.0			50			4.5			.030			μsec

switching time test circuit

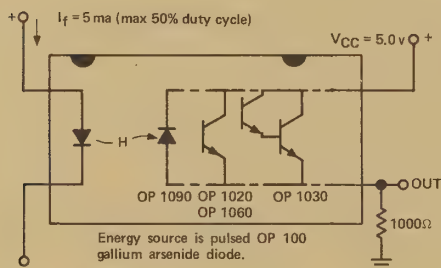
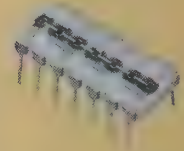
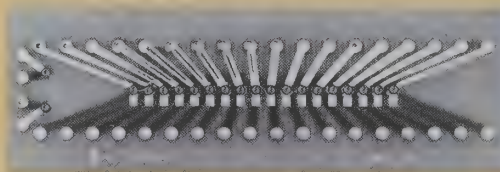


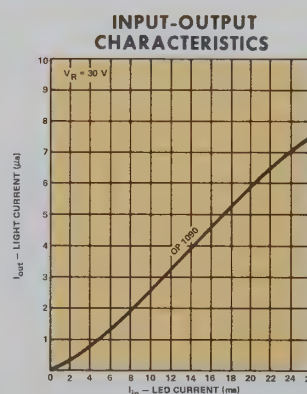
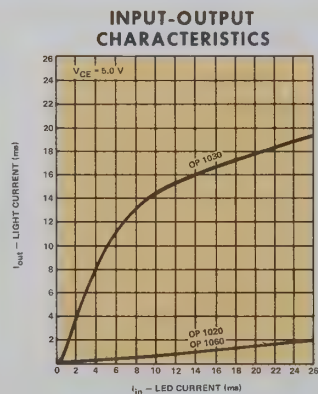
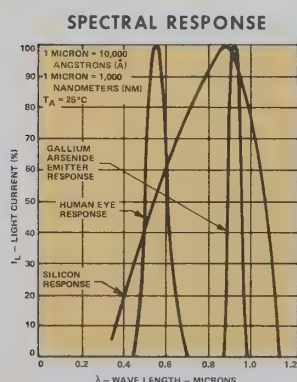
FIGURE 1



Complete Optoelectronic Production Capabilities

OPTRON can provide complete discrete, hybrid or monolithic optical arrays, pre-assembled and pre-tested, to your specifications. In addition, OPTRON is experienced and capable of working on your most stringent custom requirements or interface problems. An OPTRON-assembled functional module offers you significant system-cost and performance advantages. Contact your OPTRON sales representative or the factory direct for additional information.

Typical Design Graphs



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OPTRON, INC.

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Types OP 1050, OP 1052, OP 1053, OP 1056 High Voltage Optically Coupled Isolators

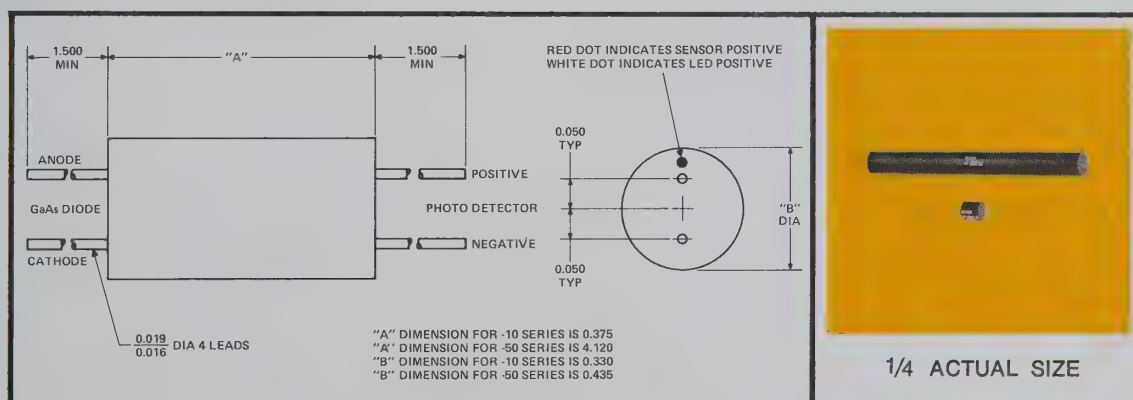
Bulletin No. 1017 August 1972

General Description

The OP 1050, 1052, 1053, and 1056 are high voltage optically coupled isolators comprised of a gallium arsenide LED and silicon sensor. Units are available with a photodiode (OP 1050), phototransistor (OP 1052, OP 1056) and photodarlington (OP 1053) sensing element. The photodiode version provides maximum bandwidth while the phototransistor and photodarlington versions offer higher coupling efficiency.

Isolation breakdown rating between input and output is 10 Kv minimum for the -10 series and 50 Kv minimum for the -50 series.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — see Note 1)

	OP 1050	OP 1052	OP 1053	OP 1056
Detector Only				
Maximum Voltages				
BV _{CEO} Collector-to-Emitter		25 v	15 v	25 v
BV _{ECO} Emitter-to-Collector		5 v	5 v	5 v
BV _R Reverse Voltage	25 v			
Maximum Power Dissipation (See Note 2) . .	50 mw	50 mw	50 mw	50 mw
Input Diode Only				
BV _R Maximum Reverse Voltage	2 v	2 v	2 v	2 v
Maximum Power Dissipation (See Note 2) . .	50 mw	50 mw	50 mw	50 mw
Detector and Input Diode				
Maximum Temperatures				
Storage	-65°C to +85°C	+85°C	+85°C	+85°C
Operating	-65°C to +70°C	+70°C	+70°C	+70°C
Soldering (See Note 3)		+240°C for 3.0 minutes		

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

NOTE 3. Leads only. All devices.

Types OP 1050, OP 1052, OP 1053, OP 1056

High Voltage

Optically Coupled Isolators

Bulletin No. 1017 August 1972

OPTRON, INC.

input diode electrical characteristics at 25°C free-air temperature (all devices unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
BV_R	Reverse Breakdown Voltage	$I_R = 100 \mu a$	2			v
V_F	Static Forward Voltage	$I_F = 50 ma$			1.6	v

detector electrical characteristics at 25°C free-air temperature (all devices unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
			OP 1050			OP 1052			OP 1053			OP 1056			
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	$I_{CEO} = 100 \mu a$				25			15			25			v
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	$I_{ECO} = 100 \mu a$				5			5			5			v
B_{VR}	Reverse Voltage Breakdown	$I_R = 100 \mu a$	25												v
I_O	Output Current	$V_R = 5.0 v$, Input Diode $I_F = 30 ma$	10												μa
I_O	Output Current	$V_R = 5.0 v$, Input Diode $I_F = 20 ma$				0.13			2.0			0.8			ma
I_{off}	Output Leakage Current	$V_R = 10 v$, $I_F = 0$, (H=0)			10			25			1000			25	na
t_r	Output Current Rise Time	$V_{CC} = 5.0 v$, $I_f = 5 ma$ (max 50% duty cycle) $R_L = 100 \Omega$ (See Fig. 1)		0.10			1.0			50			1.5		μsec
t_f	Output Current Fall Time	$V_{CC} = 5.0 v$, $I_f = 5 ma$ (max 50% duty cycle) $R_L = 100 \Omega$ (See Fig. 1)		0.10			2.0			50			4.0		μsec

switching time test circuit

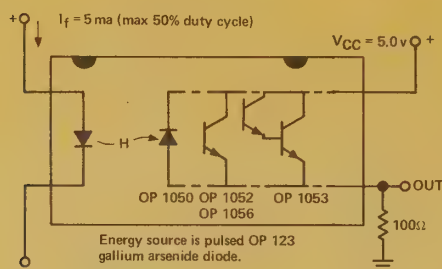
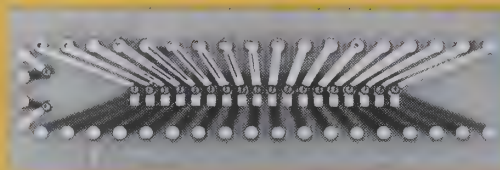


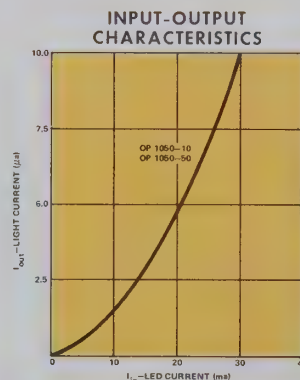
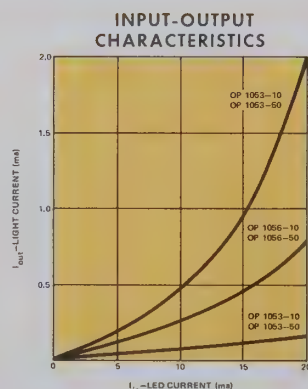
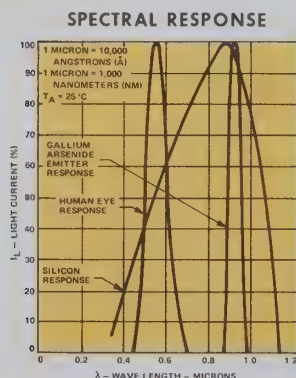
FIGURE 1



Complete Optoelectronic Production Capabilities

OPTRON can provide complete discrete, hybrid or monolithic optical arrays, pre-assembled and pre-tested, to your specifications. In addition, OPTRON is experienced and capable of working on your most stringent custom requirements or interface problems. An OPTRON-assembled functional module offers you significant system-cost and performance advantages. Contact your OPTRON sales representative or the factory direct for additional information.

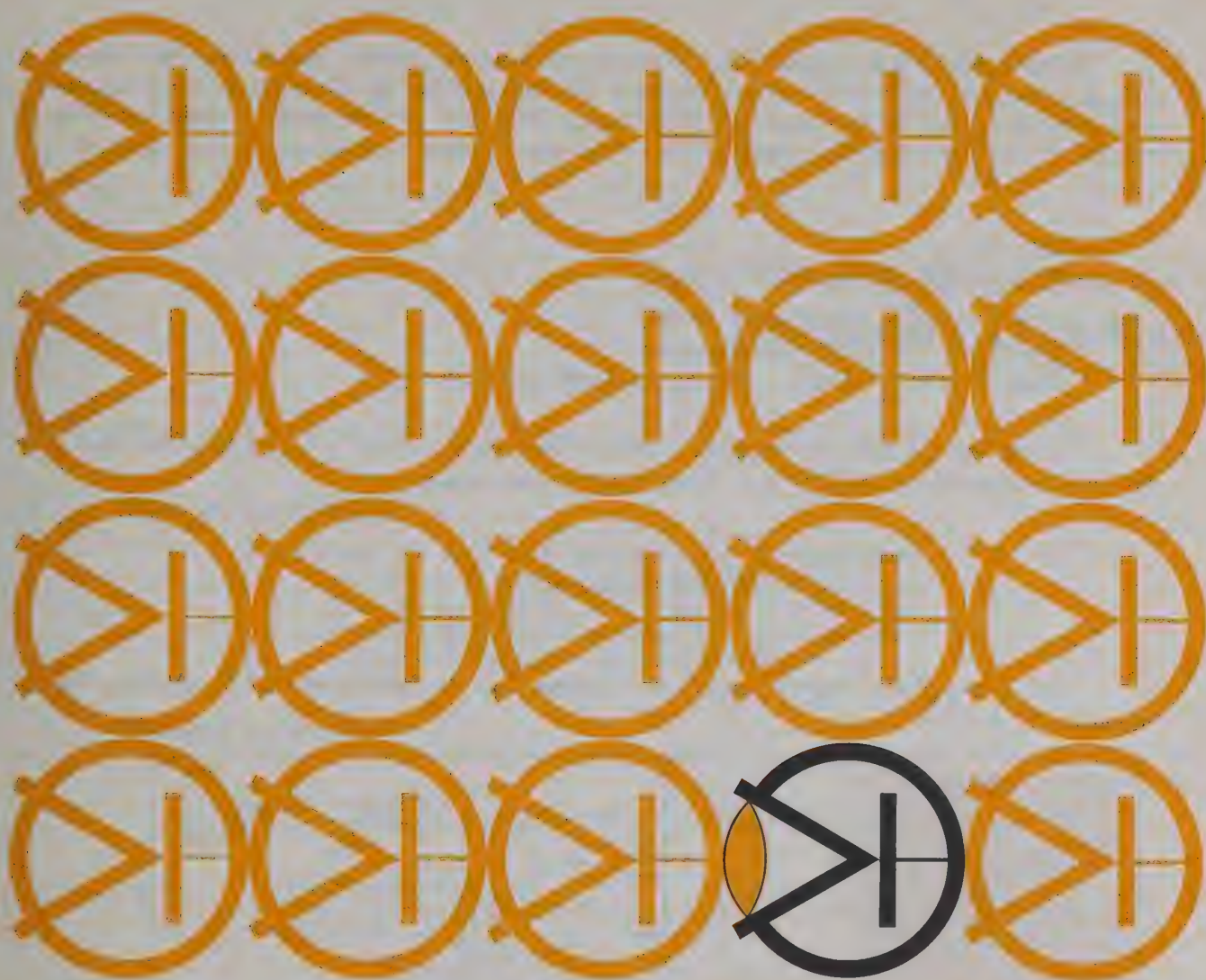
Typical Design Graphs



REPRESENTED BY:

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OPTOELECTRONICS
FOR INDUSTRY

JUNE 1, 1970

APPLICATION BULLETIN NO. 2

**THE USE OF THE OP 666 AS A
PHOTOMETRIC LIGHT STANDARD**

William Nunley
Manager of Quality Engineering

The OP 666 is a standard OP 600 that has been calibrated under laboratory conditions. The " I_L " in micro amperes has been plotted against " H " in milliwatts per square centimeter for color temperatures of 2100°K and 2870°K. This paper is intended to offer several methods of using this standard to define use condition within an electro-optical system.

METHOD A

Unknown - " H " (Irradiance Level)

Known - " CT " (Color Temperature)

Known - " N_{CT} " (Factor for variation of " I_L " with " CT ")

Using the OP 666 photometric standard data sheet, read " I_L " at 20mw/cm² for the color temperature of 2870°K. In the attached example:

$$I_L @ 2870^\circ K = 2000 \mu a$$

Using the given " N_{CT} ", solve for the new " I_L " at the known " CT ". Assume the known " CT " is 2470°K.

$$\begin{array}{ll}
 I_L = I_L @ CT \text{ high} & \left[1 - N_{CT} \left(\frac{CT \text{ high} - CT \text{ low}}{100} \right) \right] \\
 I_L = 2000 \times 10^{-6} & \left[1 - .052 \left(\frac{2870 - 2470}{100} \right) \right] \\
 I_L = 2000 \times 10^{-6} & \left[1 - .052 (4.7) \right] \\
 I_L = 2000 \times 10^{-6} & \left[1 - .244 \right] \\
 I_L = 2000 \times 10^{-6} & \left[.756 \right] \\
 I_L = 1512 \times 10^{-6} &
 \end{array}$$

Plot the 1512 micro amperes at 20 mw/cm² and draw a 2470°K color temperature " I_L " versus " H " that is parallel to the two given curves.

The standard unit may now be placed in the application slot and " I_L " measured. With the measured value of " I_L ", go vertically until you intersect the constructed curve. The intersection point will provide the " H " level for your application.



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Type OP 666 Serial No. Example

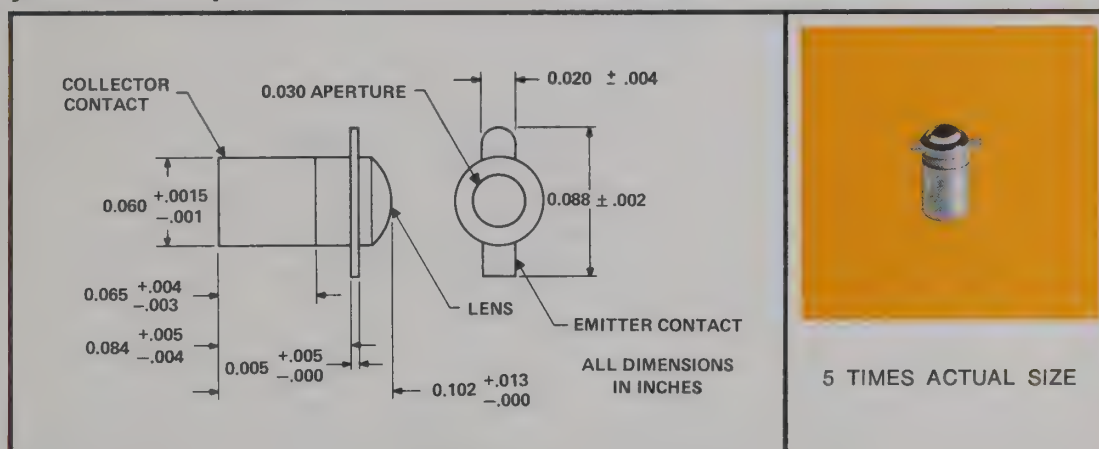
Photometric Light Standard

Bulletin No. 1005 September 1969

General Description

The OP 666 is a microminiature photo-transistor encased in a hermetic glass-to-metal seal package. This two terminal device is intended to be mounted directly to a printed circuit board. This device has been calibrated for use as a photometric standard.

Physical Description



absolute maximum ratings at 25°C free-air temperature (unless otherwise specified — See Note 1)

Maximum Voltages

BV_{CEO}	Collector-to-Emitter Voltage	50 v
BV_{ECO}	Emitter-to-Collector Voltage	7 v

Maximum Power Dissipation (See Note 2) 50 mw

Maximum Temperatures

Storage	-65° to +150°C
Operating	-65° to +125°C
Soldering	240°C for 3.0 minutes

NOTE 1. Ratings at which device performance may be impaired if exceeded.

NOTE 2. Derate linearly to 125°C free-air temperature at the rate of 0.5 mw/°C.

The OP 666 is a standard OP 600 that has been calibrated under laboratory conditions. The " I_L " in micro amperes has been plotted against " H " in milliwatts per square centimeter for color temperatures of 2100°K and 2870°K. This paper is intended to offer several methods of using this standard to define use condition within an electro-optical system.

METHOD A

Unknown - " H " (Irradiance Level)

Known - " CT " (Color Temperature)

Known - " N_{CT} " (Factor for variation of " I_L " with " CT ")

Using the OP 666 photometric standard data sheet, read " I_L " at 20mw/cm² for the color temperature of 2870°K. In the attached example:

$$I_L @ 2870^\circ K = 2000 \mu a$$

Using the given " N_{CT} ", solve for the new " I_L " at the known " CT ". Assume the known " CT " is 2470°K.

$$\begin{array}{ll}
 I_L = I_L @ CT \text{ high} & \left[1 - N_{CT} \left(\frac{CT \text{ high} - CT \text{ low}}{100} \right) \right] \\
 I_L = 2000 \times 10^{-6} & \left[1 - .052 \left(\frac{2870 - 2470}{100} \right) \right] \\
 I_L = 2000 \times 10^{-6} & \left[1 - .052 (4.7) \right] \\
 I_L = 2000 \times 10^{-6} & \left[1 - .244 \right] \\
 I_L = 2000 \times 10^{-6} & \left[.756 \right] \\
 I_L = 1512 \times 10^{-6} &
 \end{array}$$

Plot the 1512 micro amperes at 20 mw/cm² and draw a 2470°K color temperature " I_L " versus " H " that is parallel to the two given curves.

The standard unit may now be placed in the application slot and " I_L " measured. With the measured value of " I_L ", go vertically until you intersect the constructed curve. The intersection point will provide the " H " level for your application.

METHOD B

Unknown - "CT" (Color Temperature)

Known - "H" (Irradiance Level)

Known - " N_{CT} " (Factor for variation of " I_L " with "CT")

Using the OP 666 photometric standard data sheet, plot a constant "H" line that passes through both furnished color temperature curves. Assume the known "H" level is 5 mw/cm^2 . The attached example would intersect at:

$$CT @ 2870^\circ K = 470 \times 10^{-6} \text{ amperes}$$

Using the measure value of " I_L " from the standard, solve for the unknown "CT". Assume the measured value of " I_L " was 350×10^{-6} amperes.

$$CT = 2870 - \left[\frac{100 \left(1 - \frac{I_{L \text{ meas}}}{I_{L \text{ graph}}} \right)}{.052} \right]$$

$$CT = 2870 - \left[\frac{100 \left(1 - \frac{350 \times 10^{-6}}{470 \times 10^{-6}} \right)}{.052} \right]$$

$$CT = 2870 - \left[\frac{100 (1.744)}{.052} \right]$$

$$CT = 2870 - \left[\frac{100 (.255)}{.052} \right]$$

$$CT = 2870 - 491$$

$$CT = 2379^\circ K \text{ (Kelvin)}$$

METHOD C

Unknown - "H" (Irradiance Level)

Unknown - "CT" (Color Temperature)

Place the standard unit in the applications slot and measure " I_L ". The unknown may be established by reading the "H" level at the measured " I_L " and $2870^\circ K$ intercept. The corresponding "H" will have a potential inaccuracy of $\pm 2\%$. This inaccuracy is due to the production distribution variation with color temperature change.

Assume the measured value of " I_L " was 460×10^{-6} amperes. At this " I_L " level, go vertically on the graph and the intersection would be at an "H" level of 5 mw/cm^2 . The specification conditions would be:

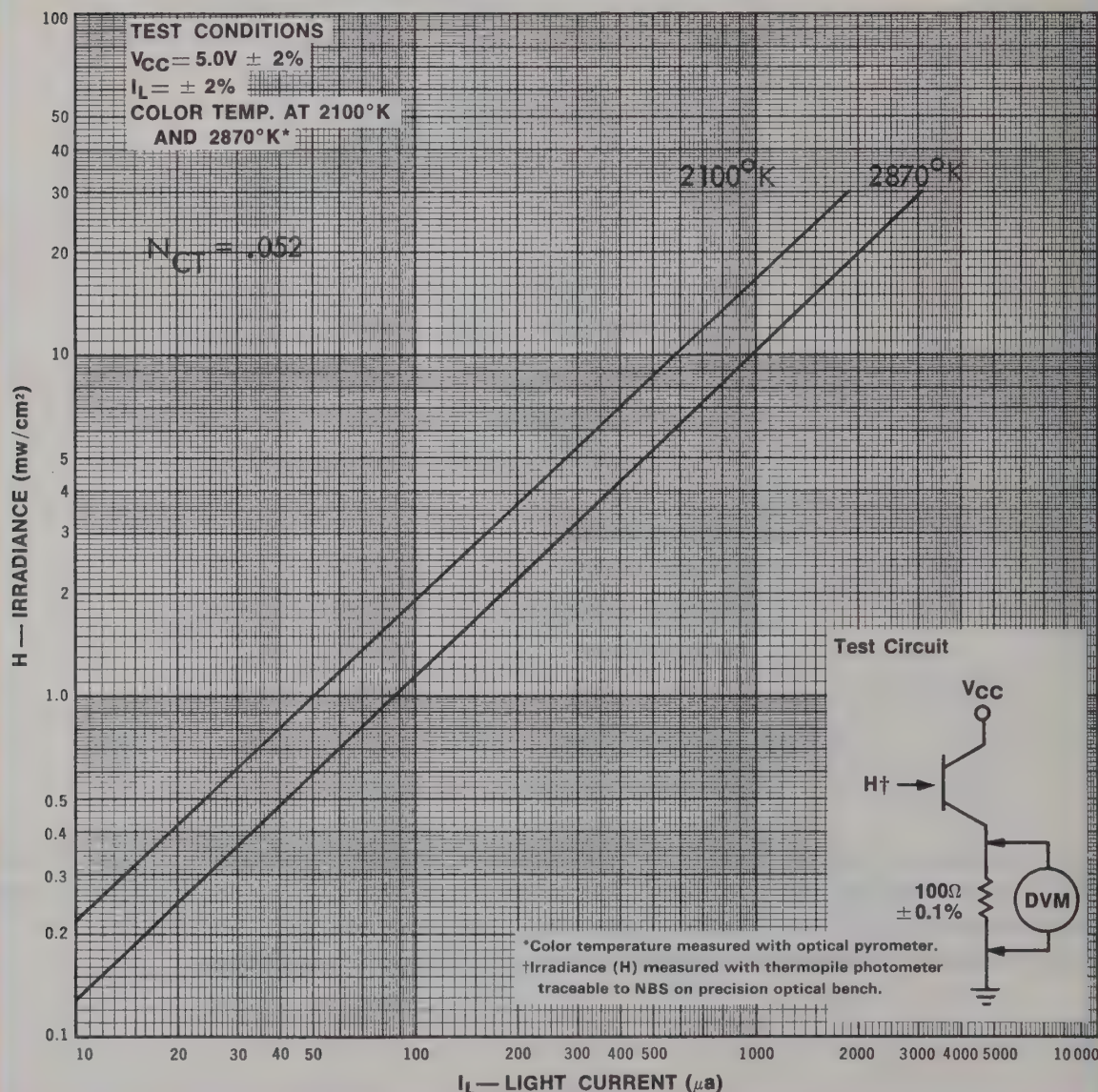
$$CT = 2870^\circ K$$

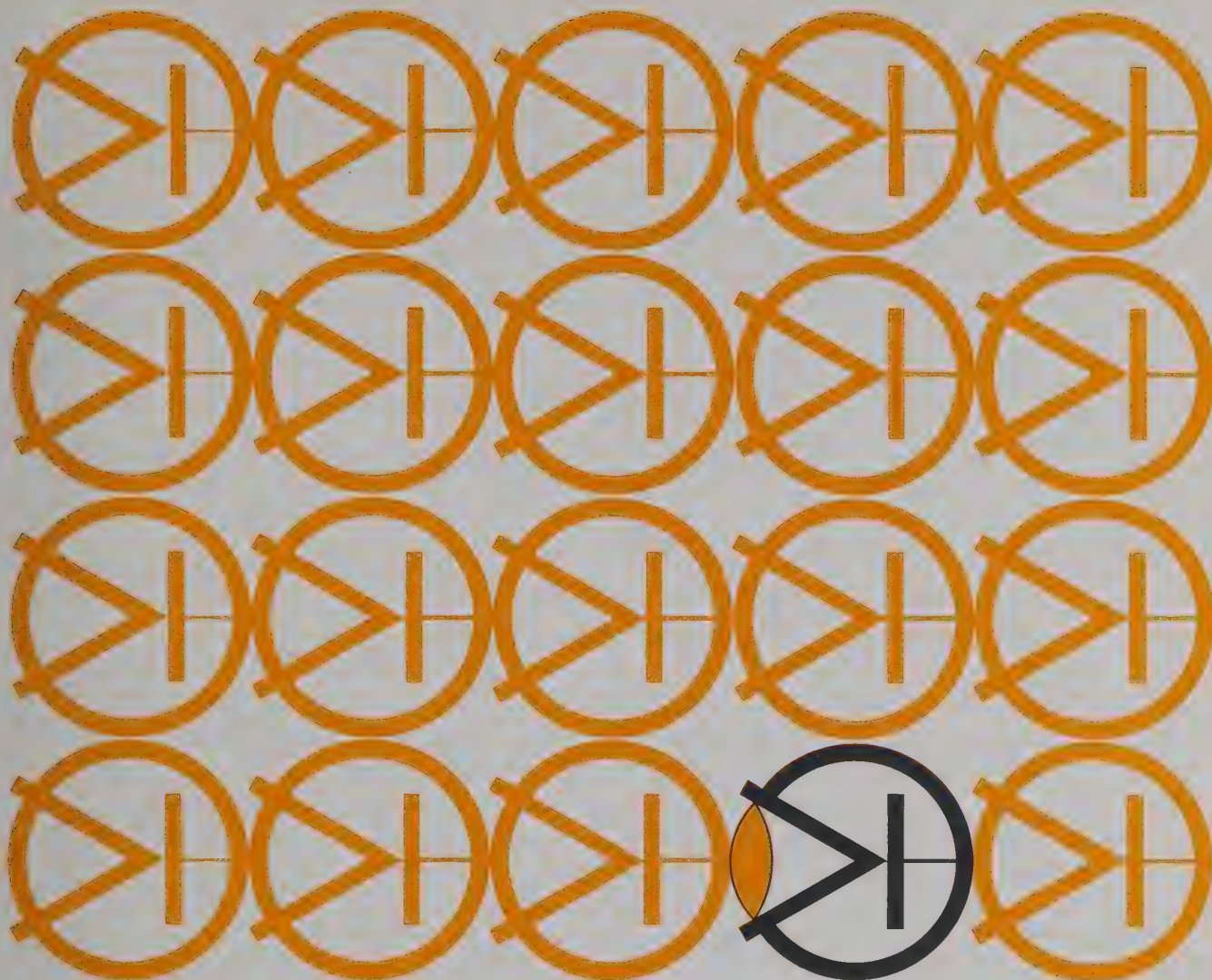
$$H = 5 \text{ mw/cm}^2$$

electrical characteristics at 25°C free-air temperature (unless otherwise specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT	TEST CONDITIONS
BV_{CEO}	Breakdown Voltage Collector-to-Emitter	50			v	$I_{CEO} = 100 \mu a$
BV_{ECO}	Breakdown Voltage Emitter-to-Collector	7			v	$I_{ECO} = 100 \mu a$
$I_L(I_{CEO})$	Light Current	2.0			ma	$V_{CE} = 5.0 v, H = 20 \text{ mw/cm}^2$
$I_D(I_{CEO})$	Dark Current			25	na	$V_{CE} = 30 v, H = 0$
$I_D(I_{CEO})$	Dark Current		10		μa	$V_{CE} = 30 v, H = 0$ $T_A = 100^\circ C$

Calibration Curve





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OPTOELECTRONICS
FOR INDUSTRY

OCTOBER 1, 1970

APPLICATION BULLETIN NO. 3

RELIABILITY DATA

William Nunley
Manager of Quality Engineering

This is the first issue of a continuing series of reports summarizing the environmental and electrical performance of Optron's products vs time or environment.

It should be emphasized that these tests are by necessity broad in scope. For specific tests or information related thereto, please contact your local representative or the factory direct.

1. Environmental tests on pill package.

Applicable products - OP100, OP300, OP600, OP620, OP900, OP1020
OP1030, OP1060, OP1090.

Vibration - 25 samples were attached to a vibration machine and subjected to a vibration of ten (10) g's in the frequency range of 30 to 2000 Hz with a sweep rate of four (4) minutes per sweep of the 30 - 2000 - 30 Hz range. This vibration was conducted in each of three (3) planes. The test samples were removed and examined visually under 40x and then tested electrically on "I_L" and "I_D".

Results - Units showed no degradation.

Solderability - 25 samples were dipped in Kester type 1544 rosin flux and dipped into a solder pot held at 246°C. The immersion and withdrawal rate was 1 + .250 inches per second. The immersion time was 2 + 1/2 minus 0 seconds. The units were then washed with 95% pure isopropyl alcohol and examined under a 40x microscope.

Results - The units had better than 95% coverage of solder on all gold plated surfaces exposed to the solder.

Hermeticity - 125 samples were exposed to three temperature cycles from -55°C to +125°C; three thermal shocks from 100°C to 0°C, tested for leaks in a helium mass spectrometer leak detector to an acceptance criteria of 5×10^{-7} cc/sec/atm. They were then tested for gross leakers by immersing each unit in silicon oil at 100°C to a level 1.0 + 0.5 inches below liquid surface. The unit shall be observed for bubbles for 1 minute. Devices that exhibit bubbles will be considered failures.

Results - There were no leakers present.

2. Life tests on pill packages (sensors)

Applicable products - OP300, OP600, OP620, OP900

Power Dissipation - 30 samples at 55°C dissipating 50 mw for 1000 hours.
Less than 5% change in I_L and I_D .

Results - No failures.

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Less than 5% change in I_L and I_D .

Results - No failures.

Sub Totals - 90,000 hours - no failures.

Reverse Bias to Collector Base Diode at 150°C . Ambient - 30 units with 12 volts bias and 100K series resistance (for 1000 hours). Less than 5% change in I_L . I_D increased from 1×10^{-9} amps to 2×10^{-9} on average. Highest reading was 10×10^{-9} amps.

Results - No failures but an upward shift of 100% in I_D .

Reverse Bias to Collector Base Diode at 150°C. Ambient - 30 units with 20 volts bias and 100K series resistance for 1000 hours. Less than 5% change in I_L . I_D increased from 1×10^{-9} amps to 4×10^{-9} on average. Highest reading was 20×10^{-9} .

Results - No failures but an upward shift of 400% in I_D .

Reverse Bias to Collector Base Diode at 150°C. Ambient - 30 units with 35 volts bias and 100K series resistance for 1000 hours. Less than 5% change in I_L . I_D increased from 5×10^{-9} amps to 20×10^{-9} amps on average. Highest reading was 50×10^{-9} amps.

Results - No failures but an upward shift of 400% in I_D .

Sub Total - 90,000 hours - no failures

Storage Life - 400 units stored at 150°C. for 1000 hours. Less than 5% change in I_D and I_L . One unit went up from 300 ohms saturation resistance to 1000 ohms. Test was run for 2676 hours.

Results - No catastrophic failures but one drift failure.

Sub Total - 1,070,000 hours - one failure

Life test on pill package summary - 1,250,000 hours - one failure.

3. Life tests on pill packages (Emitters)

Operating Life - 21 units operating at 20 mA forward current for 3100 hours.

Results - No degradation in light output.

Operating Life - 21 units operating at 40 mA forward current for 3100 hours.

Results - No degradation to light output.

Operating Life - 21 units operating at 60 mA forward current for 3100 hours.

Results - No degradation in light output.

Operating Life - 126 units operating at 50 mA forward current for 500 hours.

Results - No degradation in light output.

Operating Life Total - 200,000 hours - no failures (still in process).



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DEL STEFFEN & ASSOC., INC.

SWITCHING CHARACTERISTICS OF AN OP600 LIGHT SENSOR DRIVING AN NPN TRANSISTOR

Mike Bunyard

Manager of Applications Engineering

AUGUST 1, 1970

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APPLICATION BULLETIN NO. 4

The purpose of this Application Note is to describe the switching characteristics of a Darlington connection made up of an OP600 and a typical NPN transistor. An emitter resistor is included as an aid to improve the turn off time of the circuit. Both devices were taken from typical production runs, and no effort was made to match devices for optimum results. A light emitter that was driven by a pulse generator was used for the light source. The NPN transistor used should be a general purpose switching device with a minimum H_{FE} of 75 @ $I_C = 10 \text{ mA}$ and $V_{CE} = 10 \text{ volts}$.

It is noted from the rise times (t_r) shown in Figure 2 that the emitter-to-emitter resistor R_{EE} had an adverse effect on rise time since the OP600 must supply current to both the base of Q_2 and R_{EE} . This causes the rate of change of current in the base circuit of the Q_2 to be less than that without R_{EE} . Note also that the OP600 must furnish enough current to R_{EE} to raise the voltage across it to the base-emitter threshold voltage of Q_2 before any change in the Q_2 collector current results; thus, the turn on delay slightly is increased.

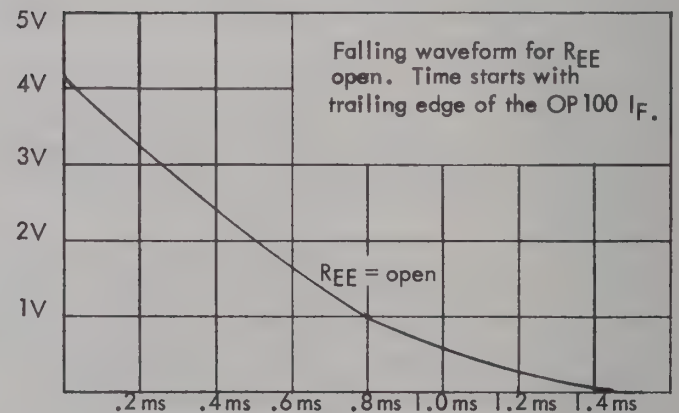
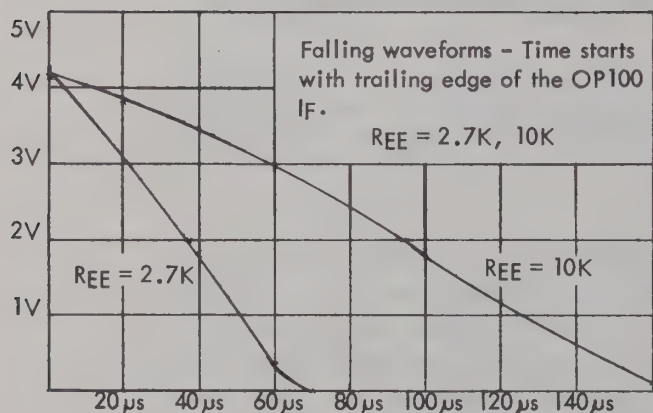
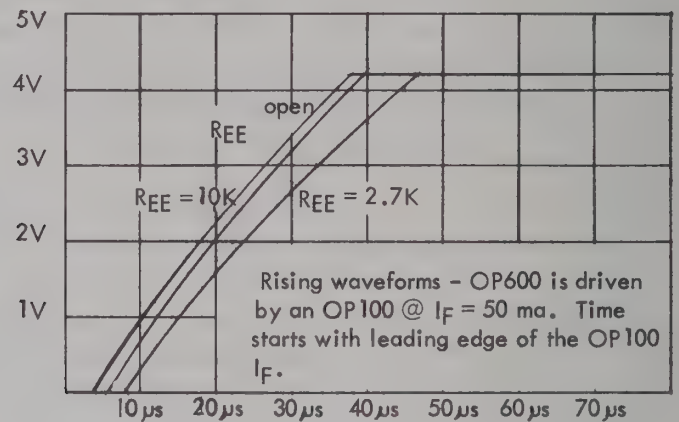
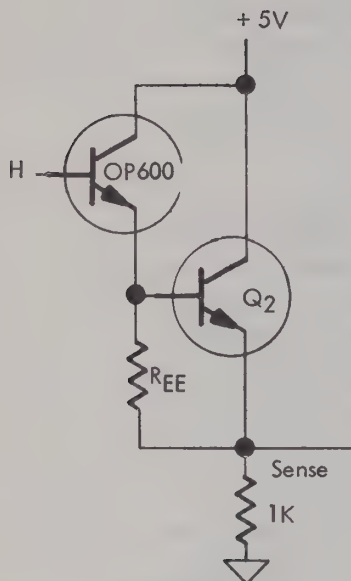
A longer rise time was recorded for the combination than would be for the individual sums under pulsed conditions, and this is primarily because the V_{CE} of the OP600 is decreasing as the combination is turning on. If the OP600 was a perfect current source (I_C did not depend upon V_{CE}) this effect would not be noticed.

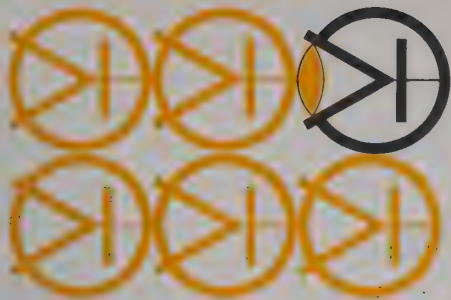
Once the combination has settled out, the V_{CE} of the Q_2 will be the sum of the active V_{BE} of Q_2 and the $V_{CE_{SAT}}$ of the OP600. This will be from .7 to 1.0V depending on the load being driven.

The fall times were improved dramatically by the inclusion of R_{EE} in the circuit. With R_{EE} removed, a fall time of 1.4 ms was observed. If R_{EE} is 10K, then a fall time of 148 μs was obtained -- some 9.4 times better than that with no R_{EE} . If R_{EE} is decreased to 2.7K, a fall time that is some 28 times better than with no R_{EE} was obtained (50 μs). A 1K R_{EE} will produce a 22 μs fall time while incurring an increase in rise time). The role of R_{EE} during the fall time is twofold. The first aids in the turn off of Q_2 and the second presents another path for the diminishing current of the OP600 in addition to the base of Q_2 which becomes a higher impedance as it's voltage drops.

Q_2 is effectively released from the circuit when it's V_{BE} drops below the minimum base-emitter diode forward threshold voltage and then R_{EE} is the only load on the OP600. The charge stored in the OP600 must flow through the parallel path of Q_2 base and R_{EE} before any appreciable V_{CE} appears across the OP600.

The above discussion shows that some R_{EE} is necessary to provide a reasonable turn off time, but that the overall sensitivity as well as rise time will be somewhat degraded by its inclusion. The problem of a high "on" voltage (for the OP600 saturated) is inherent in the Darlington connection, and may possibly present problems when interfacing to TTL and modified DTL integrated circuits but can be used effectively with standard DTL integrated circuits.





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OPTOELECTRONICS
FOR INDUSTRY

**LIGHT SENSOR COMPATIBILITY
WITH
INTEGRATED CIRCUITS**

Mike Bunyard
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AUGUST 1, 1970

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APPLICATION BULLETIN NO. 5

Silicon phototransistor switching speeds and minimum light current sensitivity are the two major parameters that may prevent one from driving integrated circuits direct. We would like to examine the options available to a designer when developing circuitry interfacing between a read station and its associated I/C logic.

The mechanical limitations associated with the typical OCR, tape, or card paper handling equipment generally defines the switching characteristics of the light sensor. The mechanical light switching problems will be discussed in detail in a later application note.

Series 7400 TTL circuits may generate noise on the outputs when driven by logic inputs with slow switching speeds.

Optron OP600 series of silicon light sensors are capable of driving TTL circuits direct if the H level at the sensor is a minimum of 4 mw/cm^2 at a color temperature of 2870°K .

The Optron OP300 Darlington phototransistor is ideally suited to drive DTL logic at H levels up to 1.0 mw/cm^2 . It is recommended that this device be considered for use in TTL systems by using a DTL hex-inverter as the first logic stage after the sensor.

The following circuits were constructed for the purpose of evaluating the switching characteristics of the different circuit configurations. An Optron OP100 gallium energy source was used in activating the light detectors. All devices used in these circuits were typical of standard production to insure evaluation representative of standard production.

The 7405 TTL gate has an open collector output while the 7404 TTL gate has a totem pole output. The 836 DTL gate produced much the same results as the 7405. No pullup resistor was used for the 836 since it contains one internally. Rise times can be expected to be degraded for capacitive loads since the internal pullup resistor is much larger than 470Ω . In some cases where an obvious problem would occur, certain devices were not tested.

The times are defined as follows:

t_{dr} - delay in μs before rise, t_r - .1/.9 rise time in μs .

t_{df} - delay in μs before fall, t_f - .9/.1 fall time in μs .

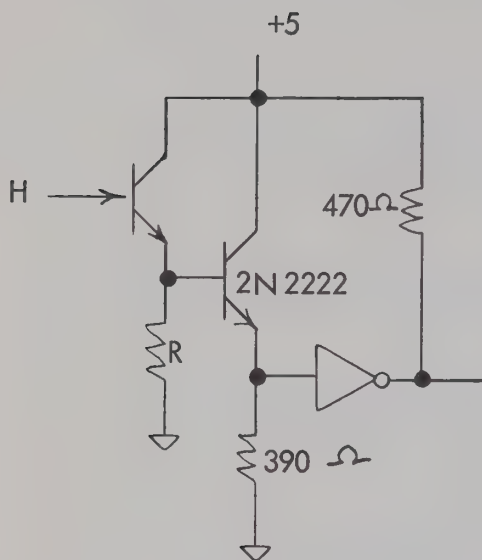


Figure 1

OP600,	$t_{dr} = 26$	
7404	$t_r = 15$	- mild oscillation
R = 10K	$t_{df} = 11$	
	$t_f = 7.5$	- mild oscillations

OP600,	$t_{dr} = 26$	
7404	$t_r = 3$	- mild oscillation
w/pullup,	$t_{df} = 11$	
R = 10K.	$t_f = 5$	- mild oscillation

OP600,	$t_{dr} = 26$	
7405	$t_r = 1$	
w/pullup,	$t_{df} = 11$	
R = 10K.	$t_f = 2$	

OP300,	$t_{dr} = 640$	
7404	$t_r = 400$	- mild oscillation
R = 1K,	$t_{df} = 12$	
	$t_f = 5$	- mild oscillation

OP300,	$t_{dr} = 640$	
7404	$t_r = 100$	- mild oscillation
w/pullup,	$t_{df} = 12$	
R = 1K.	$t_f = 3$	- mild oscillation

OP300,	$t_{dr} = 640$	
7404	$t_r = 40$	
w/pullup,	$t_{df} = 12$	
R = 1K.	$t_f = 2$	

The circuit used in Figure 1 has the light sensor driving the base of an emitter follower and a load resistance to ground. Since the gain of the emitter follower is less than unity, the gain of the sensor is slightly cut. The light sensor is allowed to saturate; so its turn off time will be lengthened. R is included to help with turn-off since without R the only path for the charge in the sensor to flow is the high impedance base circuit of the emitter follower. Note that for the OP600 used, not enough drive was available to decrease R to 2.7K.

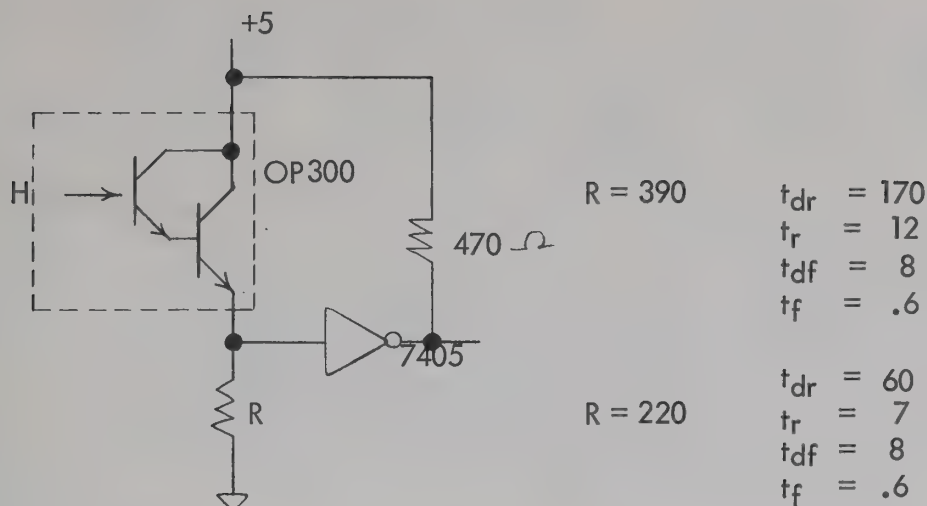


Figure 2

The transistor emitter follower was deleted in Figure 2 and the sensor is driving the load resistor R directly. Both values of R shown are well within the limits required to hold the input of the IC to a logical 0. The small resistance was ideal to produce a faster than normal switching time for the OP300 Darlington sensor. The light sensor in the Darlington can still saturate for this circuit if the load resistor is high enough. Note the turn on times for both values of R and remember that the turn off for the IC is the turn on for the sensor and vice-versa.

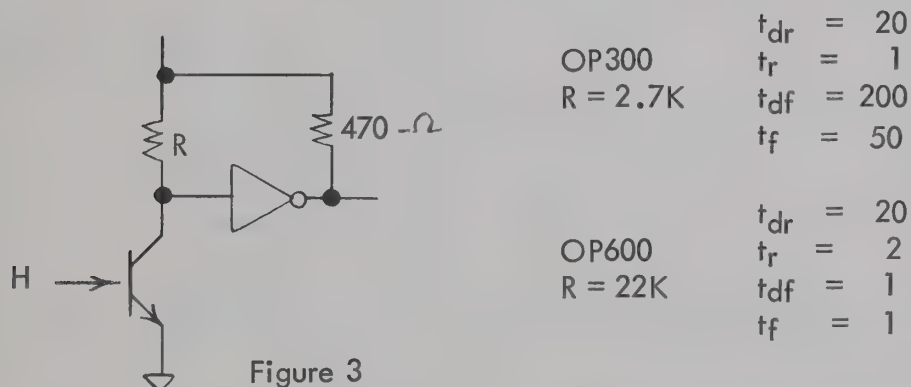


Figure 3

Note that V_{CESAT} is approx. .8V, for this.

Here again the sensor is connected directly to the IC, and this is the previously mentioned case where the sensor is to carry current from both the load resistor and the IC. The bottoming voltage of the Darlington sensor is about .8V, and this is past the maximum logical 0 voltage allowed for many IC's. Also note that the sensor will be driven to saturation.

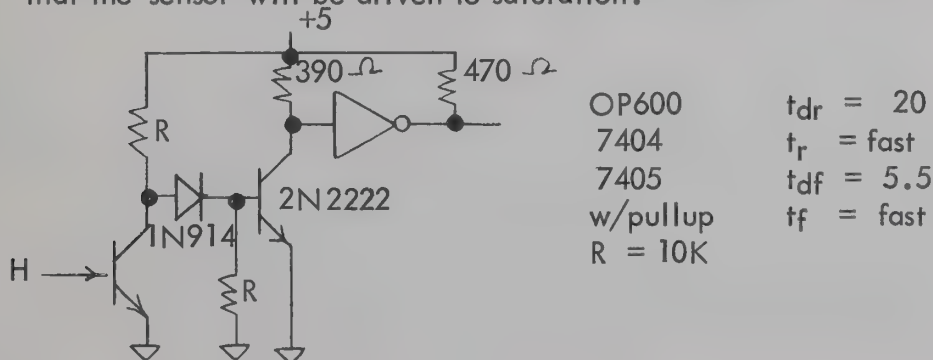


Figure 4

OP300	$t_{dr} = 1000$	
7405	$t_r = 6$	- severe oscillation
w/pullup	$t_{df} = 5$	
R = 1K	$t_f = 4$	- severe oscillation

The interface transistor used in Figure 4 is the front end of the familiar discrete NAND circuit. The output of the IC would toggle an edge triggered flip-flop when using an OP600. The slow rise and fall times associated with the low voltage, variable load resistance swings imposed upon the OP300 produced severe oscillations in the output even though the open collector IC was used. Notice that the sensor may saturate in this circuit.

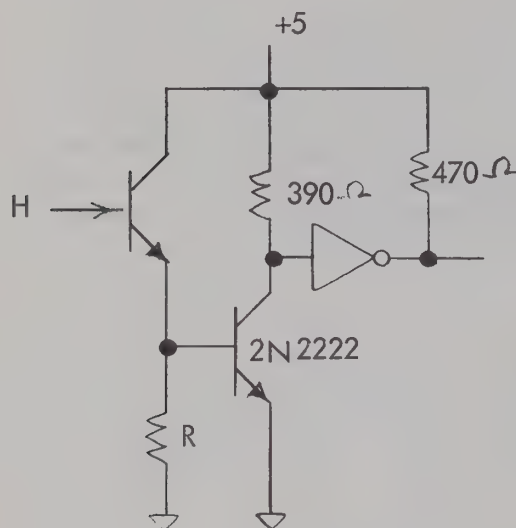


Figure 5

OP600	$t_{dr} = 6$	
7404	$t_r = \text{very fast}^*$	
7405	$t_{df} = 7$	
w/pullup	$t_f = \text{very fast}^*$	
R = 10K		

OP300	$t_{dr} = 6$	
7404	$t_r = 1$	- mild oscillation
7405	$t_{df} = 70$	
R = 1K	$t_f = 5$	- mild oscillation

OP300	$t_{dr} = 6$	
7405	$t_r = \text{fairly fast}^{**}$	
w/pullup	$t_{df} = 70$	
R = 1K	$t_f = \text{fairly fast}$	

* indicates that the waveform will toggle an edge triggered flip-flop.

** indicates fairly constant toggling of an edge triggered flip-flop.

The conclusions that may be reached from the data obtained indicate that when going into an ungated TTL circuit, the open collector circuit yields a cleaner waveform, and a pullup resistor on the totem pole decreases the rise time of that type of network. The circuit in Figure 5 produced the best switching times of the circuits tested, for the sensor was not allowed to saturate, and the buffer transistor provided gain. Even the OP300 provided very good switching times.

It is to be stressed that the data taken was from a light source that had a fast switching time, and if light pulses are generated mechanically, the switching characteristics are degraded accordingly. The principles involved in the interface influence the circuit characteristics in either case. If clean data is required for varying light conditions, it is suggested that data be strobed into registers at some specific time (such as the presence of a feedhold in a paper tape system) if a sync condition is available to be shaped and used for the strobe or the sense condition for strobing.



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INCOMING TEST PROCEDURES FOR SILICON LIGHT SENSORS

William Nunley
Manager of Quality Engineering

JUNE 1, 1970

APPLICATION BULLETIN NO. 6

The procedure below outlines a step by step procedure for testing silicon photo detectors.

Equipment Required:

Light Source

1. Lamp source GE 18A/T10/1P-6V
2. Power supply - 20 amps max, 10 volts max, regulated, variable HP6268A or equivalent.
3. Fixture for holding lamp.

Sensor (Photo detector)

1. Standard OP666 (Optron).
2. Sensor test socket.
3. Unit power supply - 100 mA max, 60 volt max, regulated, variable, HP6271A or equivalent.
4. Microammeter - 10 mA full scale, 10 na full scale, Keithley 414A or equivalent.
5. Voltmeter - HP3440A or equivalent.

Light Bench

1. Precise mechanical setup capable of repeating distance between sensor and light source within $\pm .025$ cm's distance.

Procedure:

1. Set the light source and the OP666 21.54 cm's apart and in precise mechanical alignment. The more precise the alignment, the more repeatable the setup. The sensor should be level with the center of the light source filament. The C_L of the sensor and the center of the filament should be on line. (This corresponds to 20 mw/cm^2 and 2870°K).
2. Apply 5.0 volts across the OP666.
3. Adjust voltage across light source until the OP666 reads the value on the furnished graph. This will be the reading at the intersection of 20 mw/cm^2 and the 2870°K curve.
4. Allow the light source to remain on 5 to 10 minutes and repeat step 3.

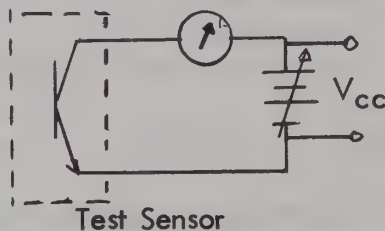
5. Replace sensor (OP666) with unit to be tested. The voltage across the unit may be varied without changing "H" or "CT".
6. Recheck setup with OP666 once per hour. Setup is correct with no more than + 2% change. OP666 should be reoriented mechanically by following step 1 and 2.
7. V_{SAT} may be measured in millivolts by switching in a 1K ohm resistor and monitoring across the resistor with the power supply set at 4 volts.
8. Dark current and breakdown voltages may be measured by setting the appropriate voltage and reading the current while the unit is shielded from all light.

NOTES:

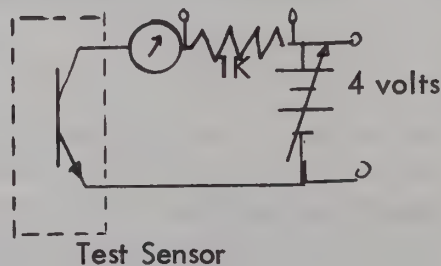
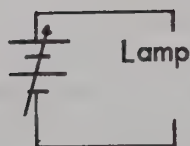
1. "H" may be varied by holding a constant color temperature (steps 1 thru 4) and varying distance between the light source and the sensor until the OP666 reads the desired value. Follow the 2870°K line up or down.
2. "CT" may be varied by holding a constant "H" and constructing a new color temperature line on OP666 graph. The NCT factor on furnished graph may be used for this purpose. The distance will get closer for a constant "H" and a lower "CT". The 2100°K graph is also furnished.
3. Room background lighting becomes a factor when light current meter moves more than 1% with background lights on or off sequentially.

Circuits:

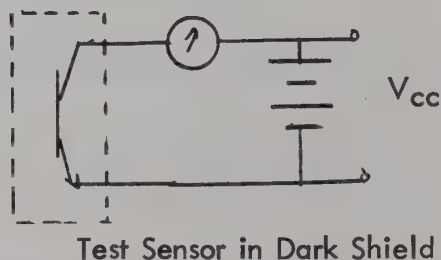
1. I_L



2. V_{SAT}



3. I_D , BV_{CEO} ,
 BV_{ECO}





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OPTOELECTRONICS
FOR INDUSTRY

**USING THE OP 666
FOR
TESTING LED's**

William Nunley
Manager of Quality Engineering

JUNE 1, 1970

APPLICATION BULLETIN NO. 7

The procedure below outlines a step-by-step procedure for testing light emitting diodes.

Equipment Required:

LED

1. Light emitting diode.
2. Power supply - 100 mA max - 10 volts max. Regulated, Variable.
3. Fixture for holding LED.
4. 100 ohm resistor.
5. Digital voltmeter.

Sensor (Photo detector)

1. Standard OP666.
2. OP666 holder (Simple "V" block).
3. OP666 power supply - 100 mA max - 60 volt max. Regulated, Variable.
4. Microammeter - 10 mA full scale - 10 na full scale.

Light Bench

1. Precise mechanical setup capable of repeating within $\pm .025$ cm's distance between sensor and light source.

Procedure:

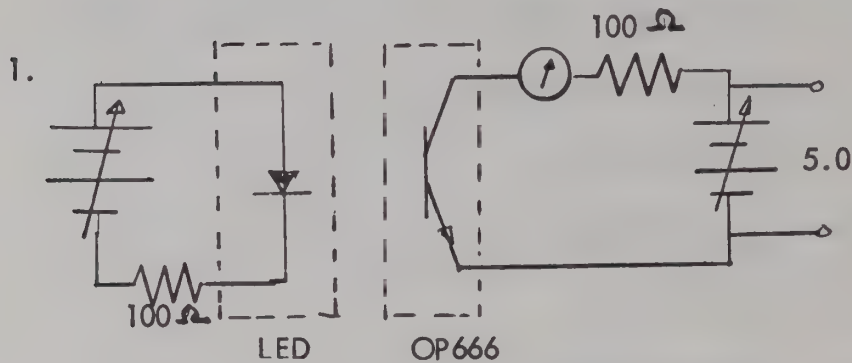
1. Set LED and OP666 .254 cm's apart and in precise mechanical alignment. The more precise the alignment, the more repeatable the accuracy. The OP666 should be level with the LED both horizontally and vertically. In addition, the C_L of the OP666 and the LED should be common.
2. Apply 5.0 volts to the sensor.

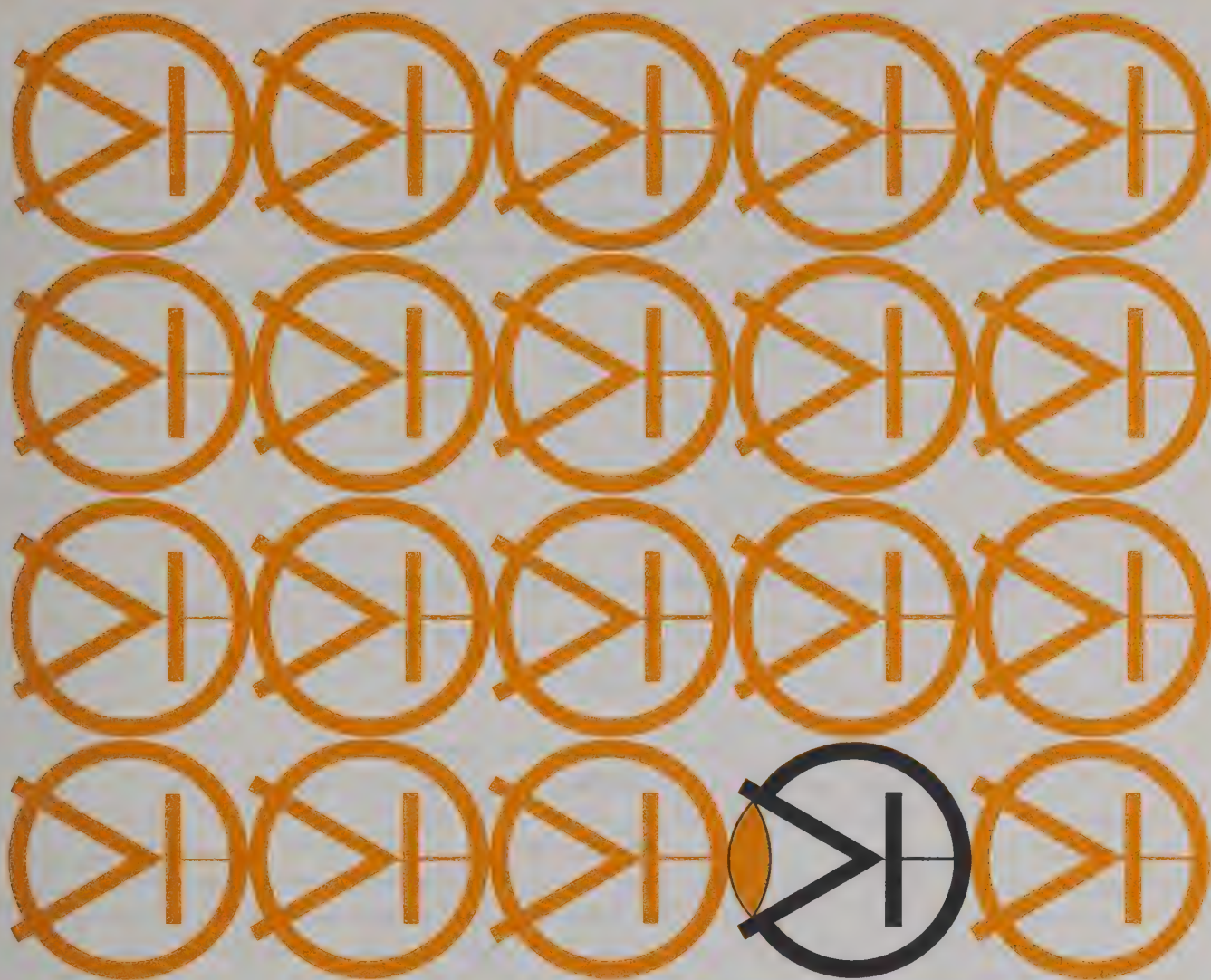
3. Apply rated current through the LED. The OP100 is rated at 50 mA.
4. Read the output current from the OP666.
5. Convert this to mw/cm^2 by referring to the 2870°K CT curve on the data sheet furnished with the OP666.

NOTES:

1. This will serve as a relative comparison of LED's.
2. Room background lighting becomes a factor when light current meter moves more than 1% with room lights on or off sequentially.

Circuits:





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OPTOELECTRONICS
FOR INDUSTRY

JUNE 1, 1970

APPLICATION BULLETIN NO. 8

APPARENT RISE & FALL TIME OF PHOTOTRANSISTORS

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Manager of Quality Engineering

CLEVELAND
PHONE

The question of apparent slow rise and fall times on silicon sensors used in direct light applications such as hole readers has been raised several times recently. This application note is intended to clarify one aspect of that problem. The OP600 and a card with an .031" hole will be used to illustrate the problem.

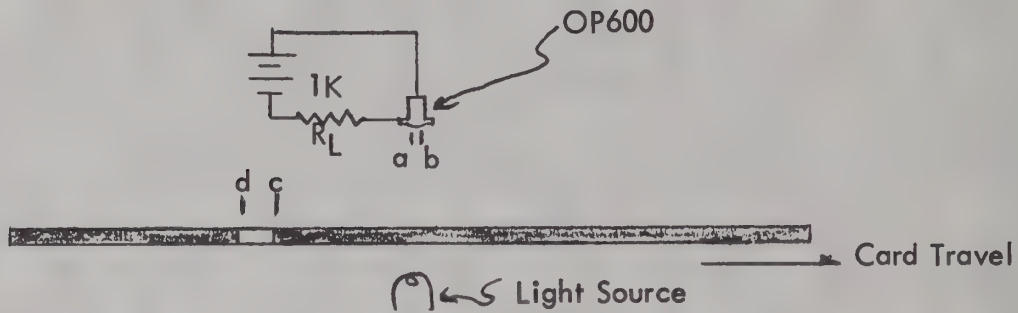
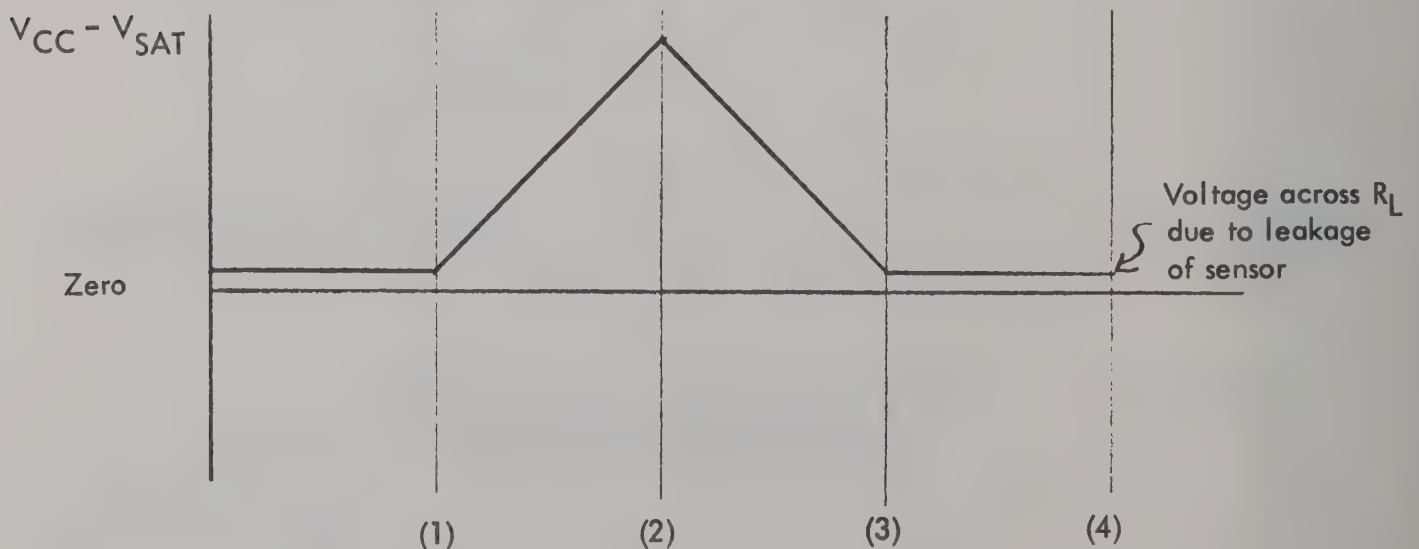


FIGURE 1

The distance from "a" to "b" in FIGURE 1 is the diameter of the aperture on the OP600 of .031". The distance from "c" to "d" in FIGURE 1 is the diameter of the hole in the card of .031". Now assume the sensor has zero rise and fall time; the sensor gain is selected so it is just driven to saturation under full light conditions; and view the voltage across the load resistor as the card is moved under the sensor.



- Point 1) - "c" coincident with "a"
- 2) - "c" coincident with "b"
- 3) - "d" coincident with "b"

FIGURE 2

The apparent rise time between points (1) and (2) in FIGURE 2 is nothing more than the transition between: none of the photo sensitive area of the sensor exposed to light, and all of the photo sensitive area of the sensor exposed to light. The apparent fall time between points (2) and (3) in FIGURE 2 is a similar transition: all of the photo sensitive area of the sensor exposed to light and none of the photo sensitive area of the sensor exposed to light.

<u>Card or Tape Speed</u>	<u>Time (1) to (2) .031" Hole in Card</u>
1000 in/sec	31 μ seconds
500 in/sec	155 μ seconds
100 in/sec	310 μ seconds
50 in/sec	1.55 milliseconds
10 in/sec	3.1 milliseconds
5 in/sec	15.5 milliseconds
1 in/sec	31.0 milliseconds

TABLE 1

Table 1 shows this apparent rise time of the system at varying speeds of the hole with respect to the sensor. As the holes become larger, the rise and fall times will remain the same but the voltage across the load will remain high longer. If the hole were .062" in diameter and the card speed was 100 inches/second then rise time would be 310 microseconds, on time would be 310 microseconds and fall time would be 310 microseconds.

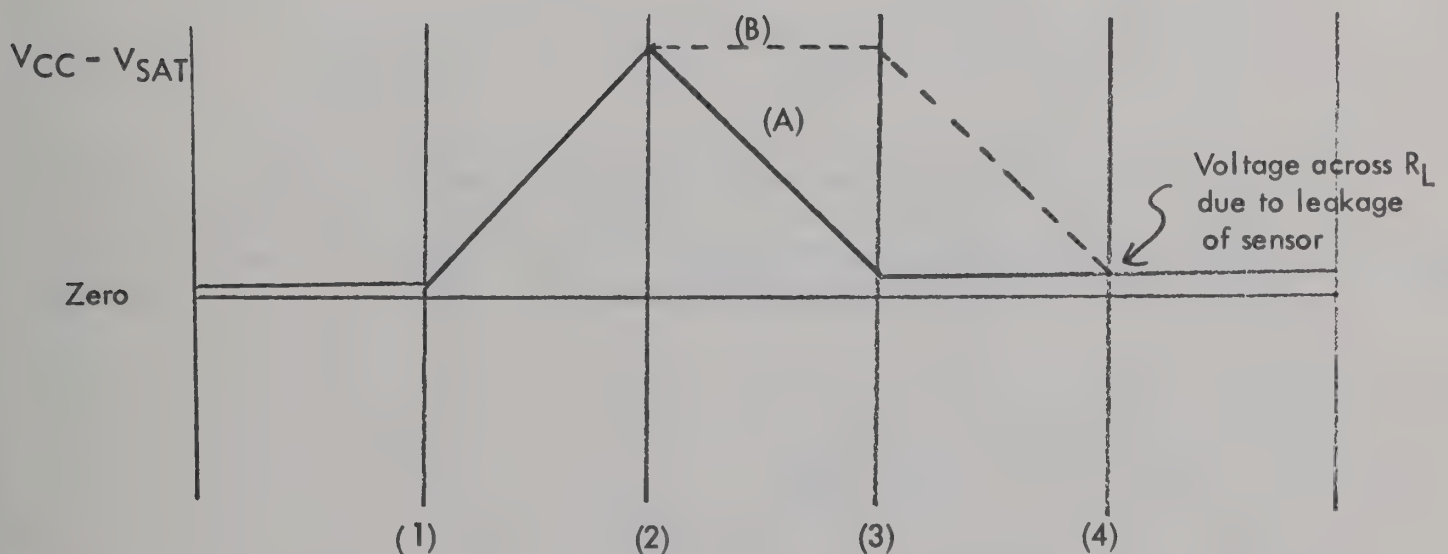


FIGURE 3

This is illustrated in FIGURE 3 where curve "A" is a repeat of FIGURE 2. Curve "B"; however, shows the path the voltage would follow if the hole size on the card was increased from .031" to .062".

This same basic curve will be followed if the system gain is viewed so that the sensor is not driven to saturation or is over driven past saturation. This encompasses both the light source and sensor variability.

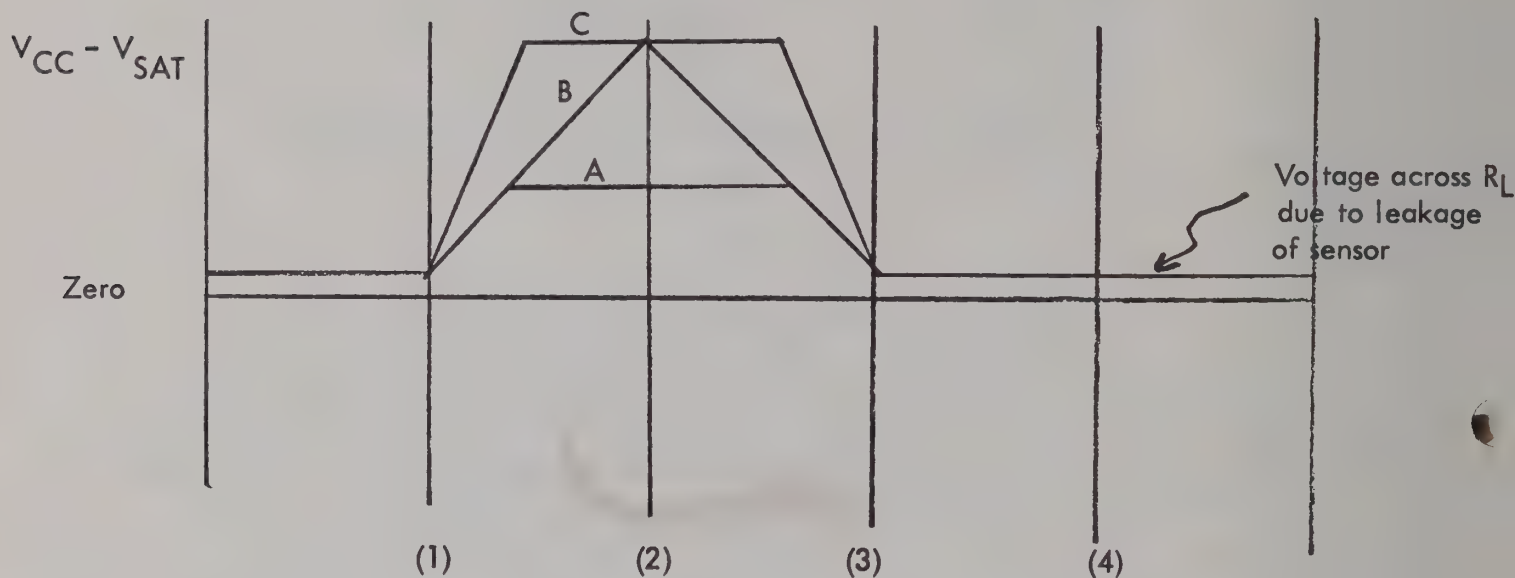
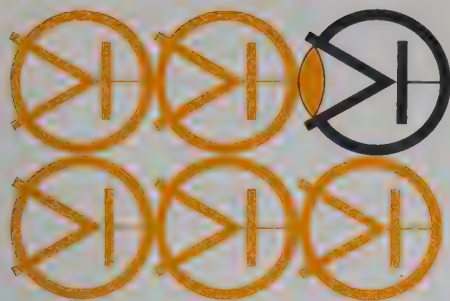


FIGURE 4

Curve "B" is again a repeat of the curve shown in FIGURE 2. Curve "A" is the path the voltage would follow if the system gain is less than that required to saturate the sensor while curve "C" is the path the voltage would follow if the system gain is greater than that required to saturate the sensor. These curves will be offset by the switching times of the sensors themselves.

Figure 2



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**OPTOELECTRONICS
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INTERFACING LIGHT SENSORS TO T²L

Mike Bunyard
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OCTOBER 1, 1970

APPLICATION BULLETIN NO.11

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When interfacing light sensors to TTL, both the logical 1 and logical 0 requirements of the IC must be satisfied. A pull-up resistor is required if the sensor is used as shown in Figure 1. This increases the current the sensor must sink. The value of R_1 affects the switching speed of the sensor and should be kept as small as possible. The sensor must sink current from both the pull-up resistor and the IC at a $V_{CE\text{SAT}}$ of less than the maximum voltage allowed for a logical 0 condition. System noise immunity is reduced by $V_{CE\text{SAT}}$ voltages that exceed the maximum logical 0 voltage condition.

The "totem-pole" output section of the TTL IC may create a problem when driven by light sensors. Both transistors of the "totem-pole" are active during switching, and the device requires a much higher supply current. Slow rise and fall times of the sensor output waveform when the IC is in this particular region causes severe oscillations in the IC output waveform during its transition from one logic state to the other. The best method of circumventing this problem is to use a squaring circuit between the sensor and the IC. A circuit such as this will be the subject of Application Note No. 12.

There frequently is not enough light drive available to use the circuit in Figure 1. Figure 2 shows a single transistor inverter whose input will not allow the sensor to saturate and has decent sensitivity. The added gain of the transistor improves the edges of waveform, and the switching time of the sensor is improved since it is working into a low input impedance. This is one of the easiest circuits to use for lower light levels and may reduce the oscillation problems discussed earlier. The transistor output may be used in a gated operation where the gating input goes up after the sensor has had time to settle to steady state. Gating the data from paper tape with respect to the feed hole is an example of this type of control.

The use of a Darlington phototransistor to directly interface to TTL logic as shown in Figure 3 is not recommended. Darlington $V_{CE\text{SAT}}$ voltages exceed the maximum guaranteed logical "0" voltage for TTL.

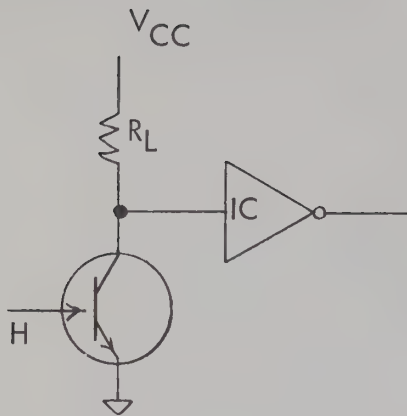


Figure 1

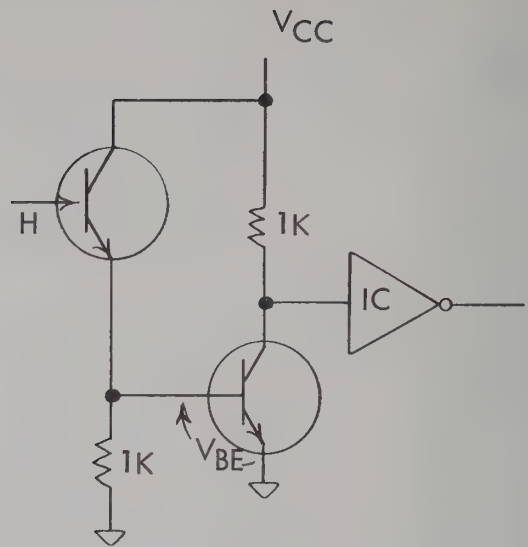


Figure 2

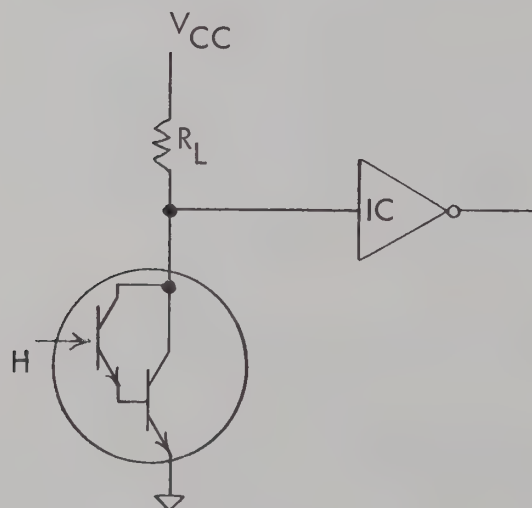
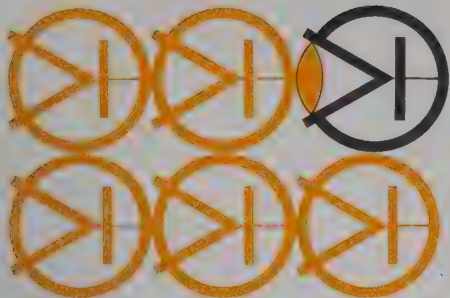


Figure 3



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**OPTOELECTRONICS
FOR INDUSTRY**

**A SQUARING CIRCUIT FOR
INTERFACING LIGHT SENSORS
TO T²L AND DTL**

Mike Bunyard
Manager of Applications Engineering

OCTOBER 1, 1970

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APPLICATION BULLETIN NO.12

The switching speed of a light sensor is generally limited by the mechanical system in which it is used and not by the device itself; therefore, some shaping of the waveform is necessary before it is suitable for clocking a counter. The circuit shown in Figure 1 provides a squared output that is TTL compatible and has an emitter-follower input impedance.

Positive feedback is applied at the emitter of Q_1 which operates either as a collector loaded amplifier or an emitter follower depending upon the voltage across its collector load resistor. Q_2 functions as an inverter to drive the IC inverter and these two inverters produce the in-phase feedback necessary for regenerative action. The circuit is said to be turned on when the base of Q_1 is low enough to cause the output to be high. It is turned off when the base of Q_1 is high enough to cause the output to be low. Turn on and turn off voltages (V_O and V_f respectively) are determined by R_f , R_1 , and R_2 . If the turn off voltage is not critical, R_2 may be removed from the circuit, for its function is an effort to reduce the effects of the active loop gain on the turn off voltage.

Since only two equations in three unknowns may be written, it will be necessary to choose one value of resistance. R_f is a logical choice for the chosen value since it is directly associated with the feedback. It should be kept small and values between 2.7K and 470 Ω will suffice. Notice that the output loading is affected.

Five basic assumptions are made to analyze the circuit in Figure 1. They are:

1. Q_1 is active just before both system turn on and turn off.
2. Q_2 has just become active from cutoff prior to system turn on.
3. Q_2 has just become active from saturation prior to system turn off.
4. Both Q_1 and Q_2 are silicon transistors with an hfe of 100 to 300
@ $I_C = 50$ mA.
5. The logical 1 output voltage of the IC (V_1) is not a function of loading.

Figure 2 shows the model of the circuit just prior to turn on. The current source represents the emitter current of Q_1 , and the node common to the emitter of Q_1 , R_1 , R_2 , and R_f (denoted by "0") is the node for which the current Equation No. 1 is written. The voltage of node "a" is $V_{on} + 0.6V$.

Equation No. 2 is obtained from the model in Figure 3. It is also a current equation at node "a", but the $V_{CE\text{SAT}}$ of the IC has been replaced with the logical 1 voltage of the IC which is a nominal 3.6V. If $V_f + .6V$ is greater than about 4V, then the diode in the totem pole output structure (if there is a diode) becomes reverse biased, and no current flows through R_f . In this case, the function of R_f in Equation 2 may be deleted. If an IC inverter is used which does not have a totem pole output, it will be necessary to add a low value pull-up resistor and rewrite Equation 2.

Equation 3 is an equation for R_2 in terms of V_{CC} , V_1 , V_2 , V_f and R_f . Once a value for R_2 has been determined from Equation 3, Equation 4 may be used to solve for R_1 . V_{CC} , V_1 , V_o , and V_f are known quantities, and Equation 3 is limited to a V_f which is less than 3.4V for the circuit as described.

Table 1 lists three sets of parameter values calculated from Equation 3 and 4 for the circuit in Figure 1.

The output waveform will drive both master-slave and edge triggered TTL flip-flops satisfactorily. R_f may be shunted with a capacitor for improved switching response times.

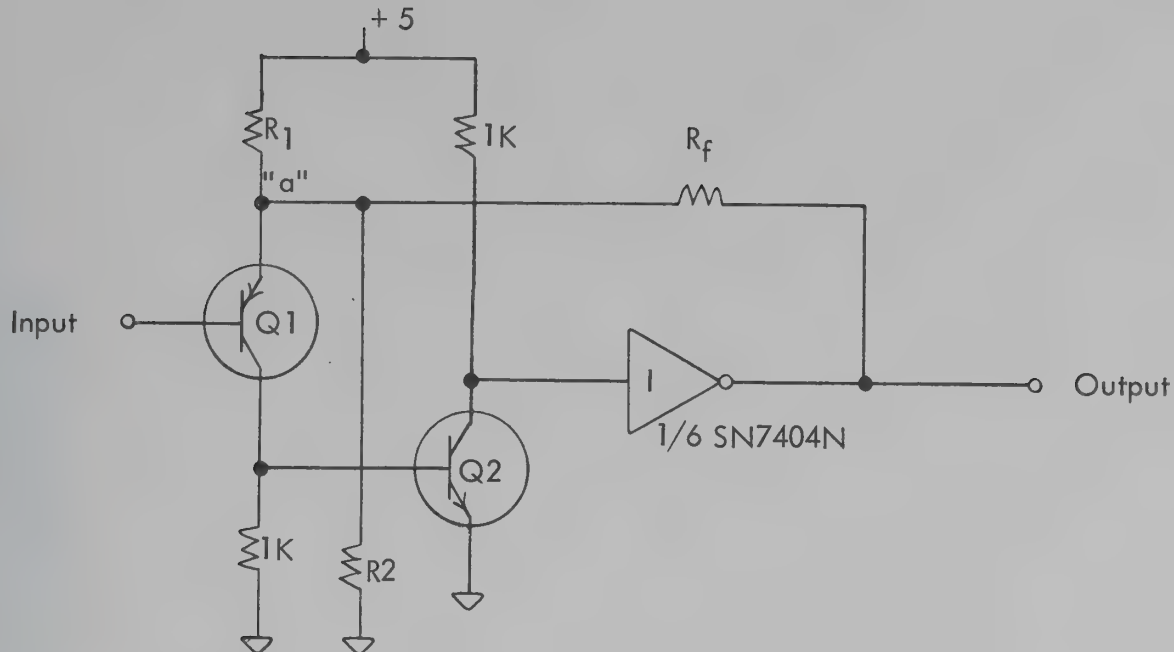


Figure 1
Squaring Circuit

Equation No. 1

$$I = \frac{5 - V_o - .6}{R_1} = .6 \text{ mA} + \frac{V_o + .6}{R_2} + \frac{V_o + .6 - .1}{R_f}$$

$$\frac{4.4 - V_o}{R_1} = .6 \text{ mA} + \frac{V_o + .6}{R_2} + \frac{V_o + .5}{R_f}$$

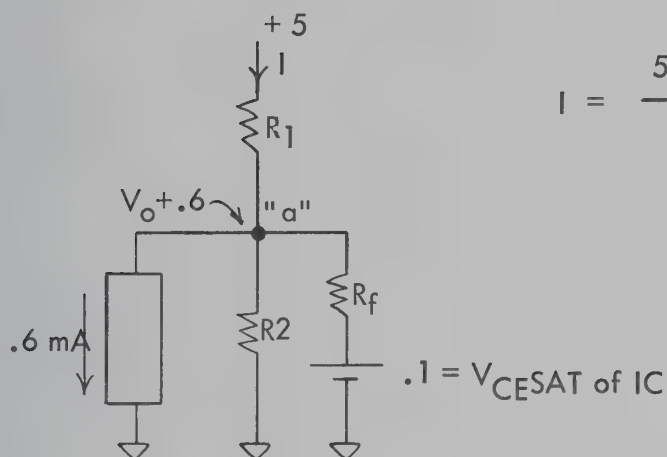


Figure 2
Circuit model for system
just prior to turn on

Equation No. 2

$$\frac{5 - V_f - .6}{R_1} + \frac{V_1 - V_f - .6}{R_f} = .7 \text{ mA} + \frac{V_f + .6}{R_2}$$

$$\frac{4.4 - V_f}{R_1} + \frac{V_1 - V_f - .6}{R_f} = .7 \text{ mA} + \frac{V_f + .6}{R_2}$$

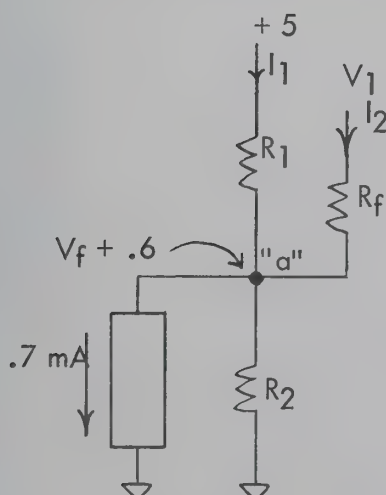


Figure 3
Circuit model for system
just prior to turn off

Equation 3

$$R_2 = \frac{R_f [(V_{CC} - V_O - .6) (V_f + .6) - (V_{CC} - V_f - .6) (V_O + .6)]}{(V_{CC} - V_f - .6) (.6R_f + V_O + .5) + (V_{CC} - V_O - .6) (V_1 - V_f - .6 - .7R_f)}$$

Equation 4

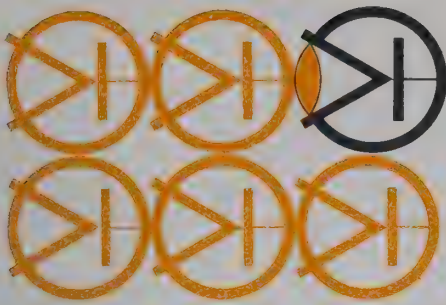
$$R_1 = \frac{R_2 R_f (V_{CC} - V_O - .6)}{.6R_2 R_f + (V_O + .6) R_f + (V_O + .5) R_2}$$

V_O V_f R_f R_1 R_2

Chosen	Actual	Chosen	Actual	Resistor Chosen	Calcu- lated	Value Used	Calcu- lated	Value Used
1	.95	2.5	2.38	1.0	1.21	1.2	2.27	2.2
2	2.07	3.2	3.3	1.0	.635	.62	3.84	3.9
1.5	1.58	3.0	3.08	1.0	.950	.910	4.65	4.7

Table 1

Voltages are in volts, resistances are in $K\Omega$, resistors are 5%, $V_{CC} = 5V$, and V_1 is assumed to be 3.6V.



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**OPTOELECTRONICS
FOR INDUSTRY**

AN ANGULAR TIMING SYSTEM

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Manager of Applications Engineering

OCTOBER 1, 1970

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APPLICATION BULLETIN NO.13

Many systems have the need to generate timing or sync pulses that are functions of a shaft position. The shaft rotation may be either variable or constant in nature depending upon its use.

The system consists of a light source, a timing disc, and a detector- amplifier. The light source used was a 28V, 40 mA non-focused lamp operated at 26V and spaced no greater than .5" from the sensor. The timing disc was constructed out of 1/16" aluminum 6" in diameter and painted black to reduce reflections. The slit was 1/16" wide but could have been a 1/16" hole just as easily. The slit does have a distinct advantage in source/sensor alignment ease though. The slit width was chosen to be at least the diameter of the sensor lens (.031") to insure enough light drive for the sensor. Extra width over and above the 1/16" figure may be necessary if pulse widths below the 20 μ s range are necessary. Smaller slits may be used if low angular velocities are to be used. Of course, if longer pulses are desired, there is no reason why the slit could not be as large as needed.

The sensor used was an OP604 which is a 6-12 mA device at 20 mw/cm².

The sensor was connected to two types of T²L compatible buffer circuits. The first (Figure 2) consisted of a single transistor inverting amplifier which featured a low excitation current and kept the OP604 from saturating, thus increasing the maximum angular velocity at which the circuit will function. The edges of the output waveform are functions of angular velocity (the rate of change of light intensity on the sensor with respect to time) and suffer at low angular velocities.

Figure 3 shows a circuit which yields a squared output waveform, but it is more complex than that of Figure 2. Also, the OP604 may saturate and in any case must drive its load resistance. The load resistance affects the switching speed of the sensor as well as the system sensitivity, ie, a low resistance increases switching speed but decreases the sensitivity. A compromise must be made between these two conflicting factors; therefore, the upper limit on angular velocities is not as high as that for Figure 2.

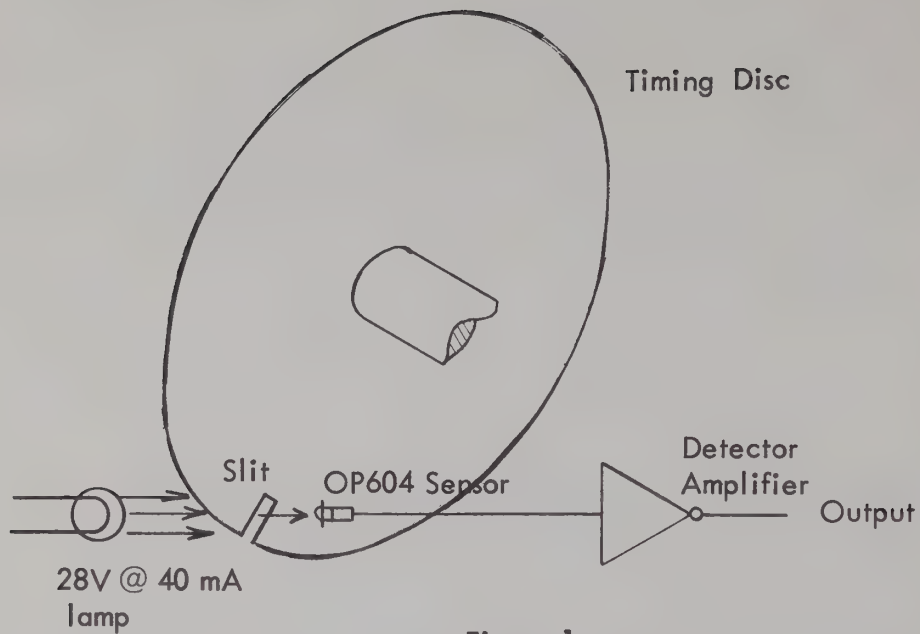


Figure 1
System Configuration

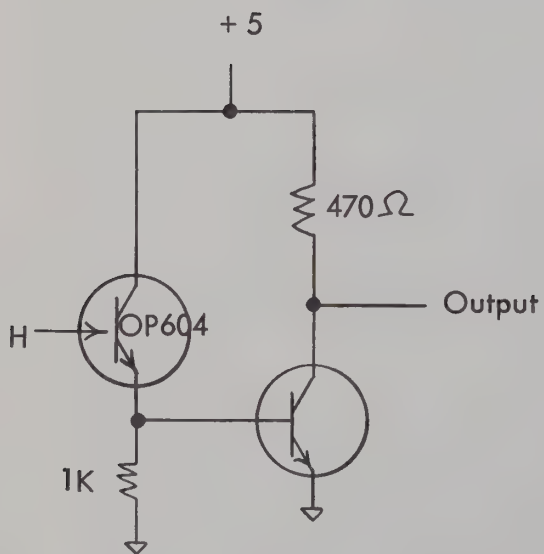


Figure 2
Inverting Amplifier

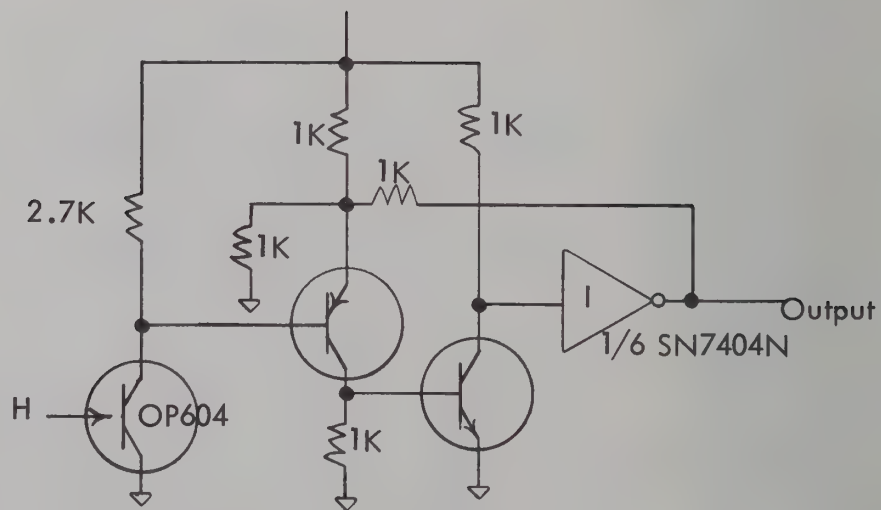
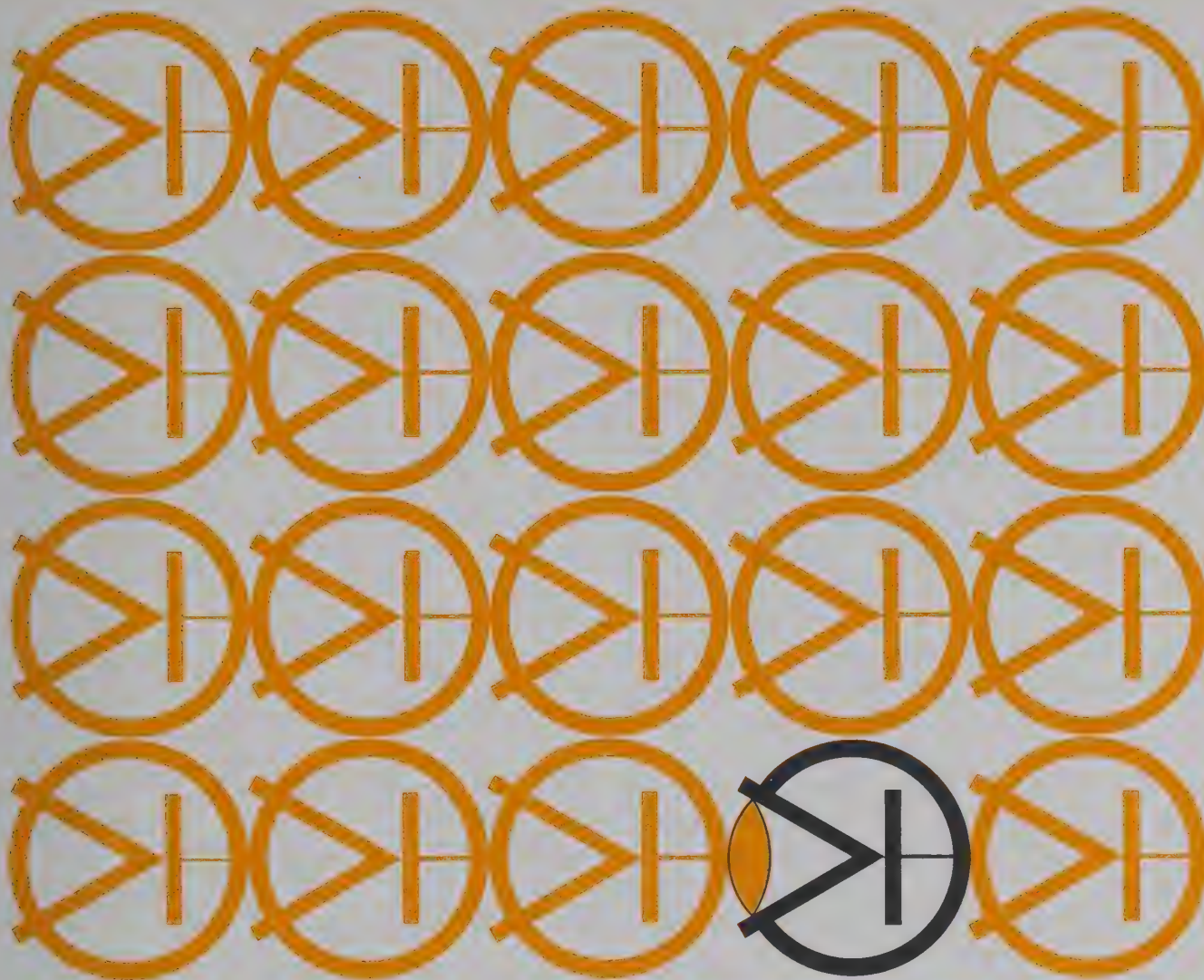


Figure 3
Regenerative Amplifier, non inverting



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OCTOBER 1, 1970

APPLICATION BULLETIN NO.14

**SENSING DATA ON
VARIABLE TRANSLUCENT MATERIALS**

Mike Bunyard
Manager of Applications Engineering

Applications involving the sensing of a "mark on" or a "hole in" translucent material often present problems when the density of the material changes. There are two distinct solutions to these problems. The intensity of the light source or the sensitivity of the sensor is controlled as a function of the material translucency. The first generally involves controlling a significant current while the second gets bulky for large numbers of sensors. Only the control of sensor sensitivity will be considered here. All circuits are TTL compatible and will operate from + 5 volts V_{CC} .

The basic philosophy will be to utilize two sensors in series as shown in Figure 1 along with two current limiting resistors to work into a summing node. The circuit is adjusted by the balance pot to be just "off" with no material in between the sensors and the light source, and it makes no difference which is the more sensitive of the two sensors. The sensors used should have matched sensitivities of 0.9 or better.

Figure 2 describes a PNP sense transistor driving an NPN inverter stage to obtain TTL compatibility. The sensitivity is somewhat low, but it will work in most cases where the material density does not vary within wide limits.

The circuit utilizing a differential amplifier described in Figure 3 exhibited good sensitivity ($>.2$ mA differential) and features ease of changing the output true logic level. Q_1 and Q_2 operate as a differential amplifier, and Q_3 ceases to conduct, Q_4 is turned off and a logical 1 appears at the output. The output may be complemented by interchanging the emitter and base connections of Q_3 .

The summing node philosophy may be extended to read mark/sense by sensing a reflected reference area and bucking it against the reflected data bit area. Figure 4 describes this method.

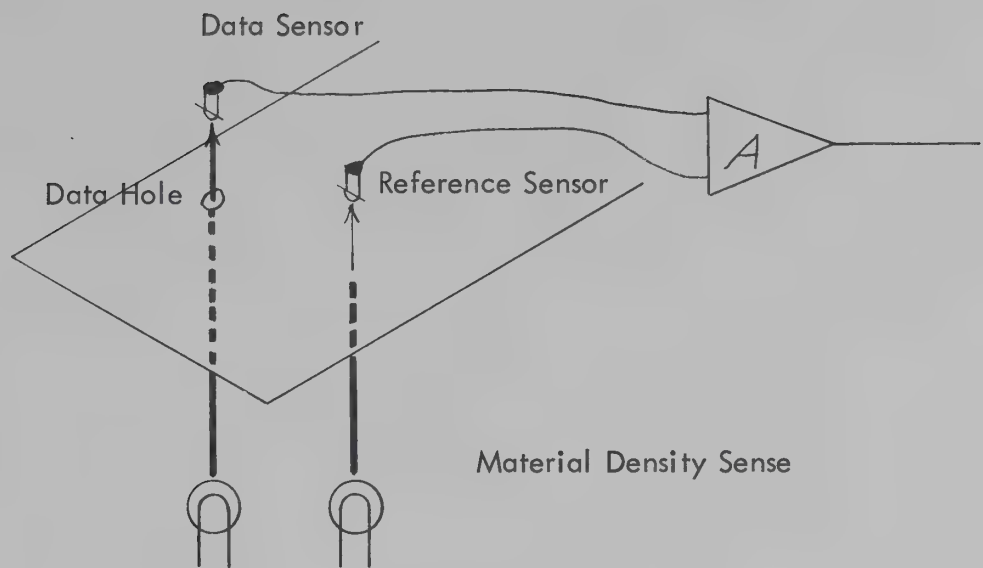


Figure 1

Sensor Placement

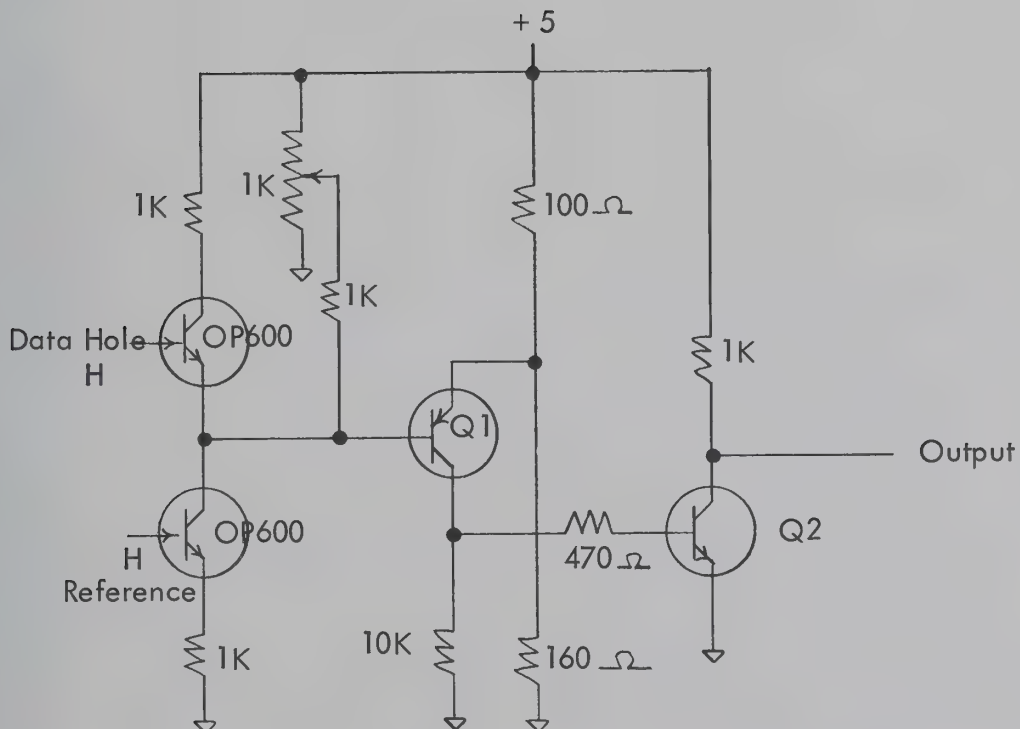


Figure 2

First circuit tested. For sensing mark instead of holes, the data and reference OP600 sensors are reversed. Transistor hfe's are greater than 75 @ $I_C = 10 \text{ mA}$.

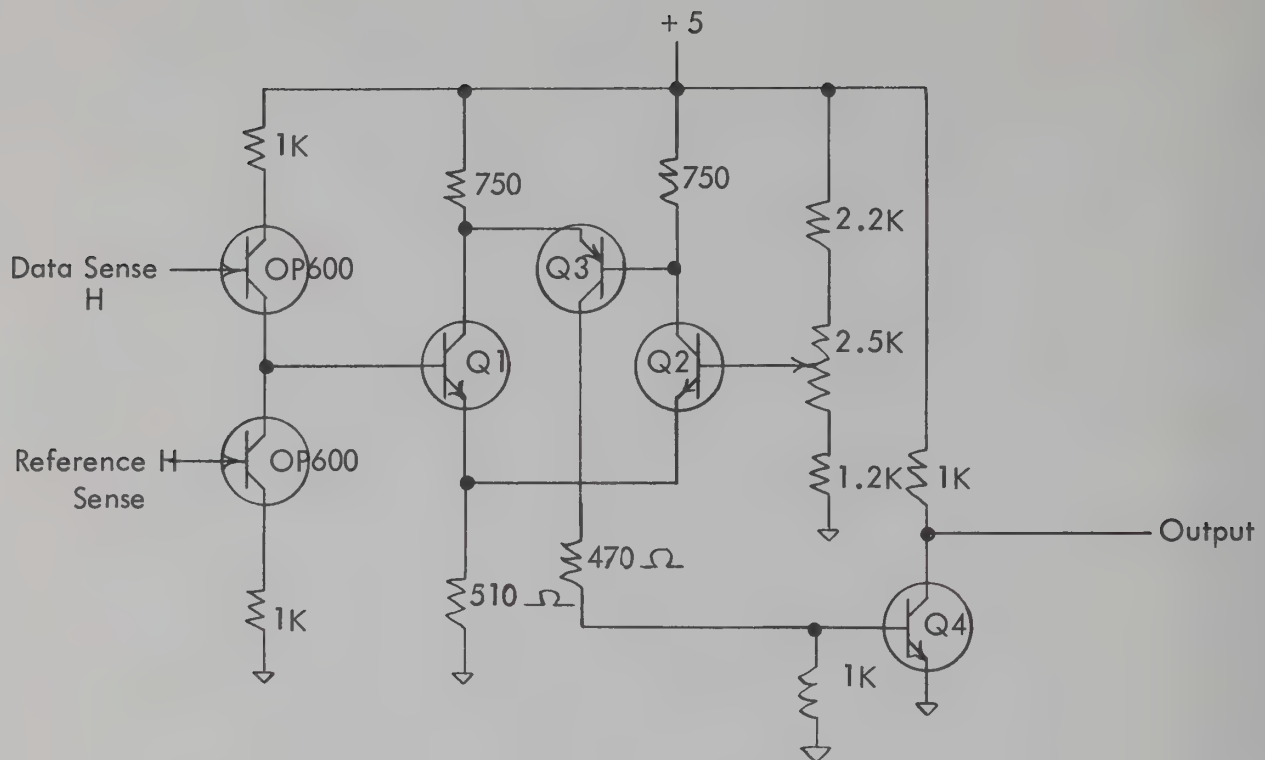


Figure 3

Second circuit tested. For sensing marks, sensor shown to be data sense becomes reference sense and vice versa.

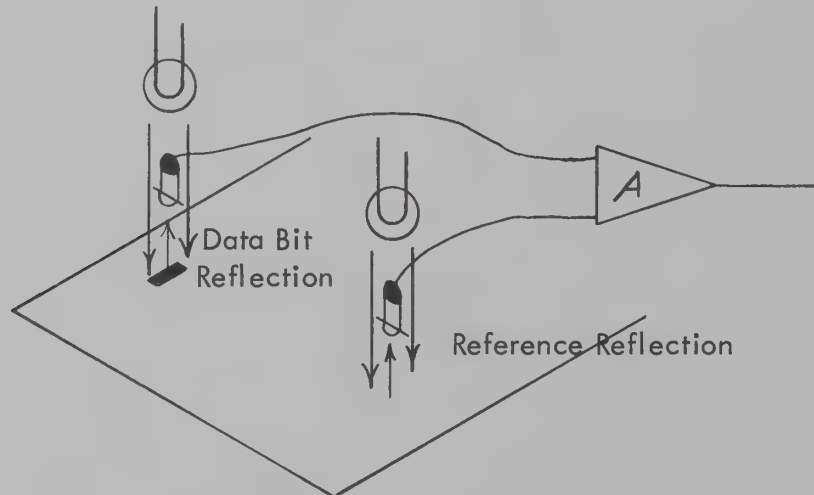


Figure 4

Extension to reflected mark sense



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DEL STEFFEN & ASSOC., INC.

AN ANALYSIS OF THE OP 100 LIGHT EMITTING DIODE

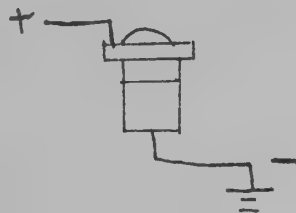
William Nunley
Manager of Quality Engineering

OCTOBER 1, 1970

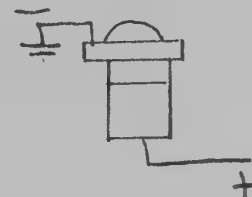
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APPLICATION BULLETIN NO.15

The OP100 is a gallium arsenide diode that when forward biased emits energy in the 900 nanometer region. It uses a planar diffused junction which provides fast pulse switching response as opposed to LED devices that use junctions fabricated by the "solution-grown" technique. See Figure 1 below for a comparison of the electrical connections normally available using the two processes.



Diffused OP100



Solution Grown

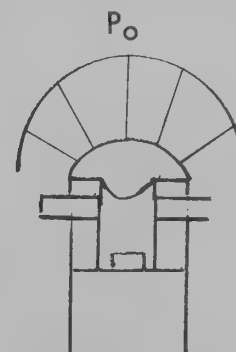
Figure 1

Total power output of the OP100 is measured in terms of Equivalent Power Out in mw/cm^2 at 2870°K . This parameter permits a user of silicon light sensors to determine an approximate figure for sensor light current available when illuminated with an OP100 at a fixed distance separation. This figure is not to be confused with a total Power out rating in mw where all the energy emitted is measured. A sensor used in conjunction may only receive a fraction of the total energy emitted. This means that the sensor light current is not representative of the total power emitted but only that which is received. It is for this reason that the equivalent power out figure in terms of mw/cm^2 more truly represents real life conditions.

The common method of measuring total power out of an LED is misleading. See Figure 2.



Sketch (a)



OP100

Figure 2

A typical OP100 chip mounted as shown in Figure 2 would radiate 230 microwatts. Mounted in the OP100 package, this total power would be cut in half. However, the power radiated per unit area directly in front of the package would be increased. Our unit is measured in equivalent power as if it were a tungsten lamp. This allows direct comparison for the output that will be obtained from a sensor.

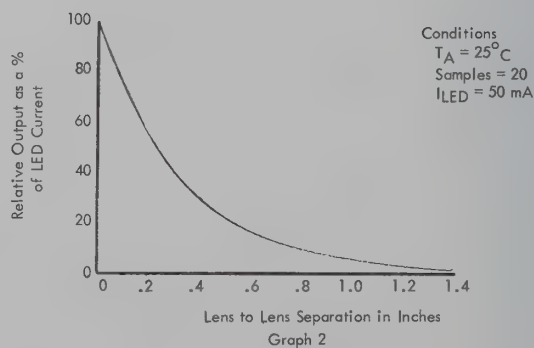
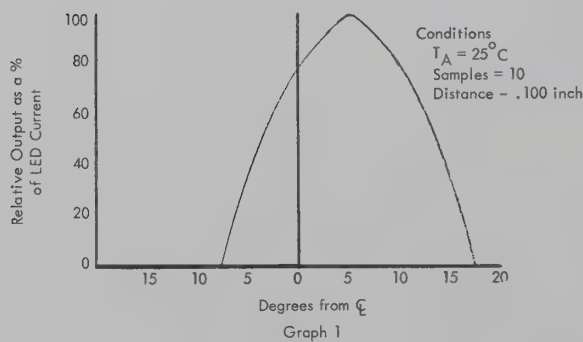
The information shown in "Graph 1" is a plot of the relative output of the LED versus angular displacement from the centerline. The unit is tested on the center line of the LED. The units will have peak power out between this point and approximately 9 degrees off center with the distribution centered at 5 degrees.

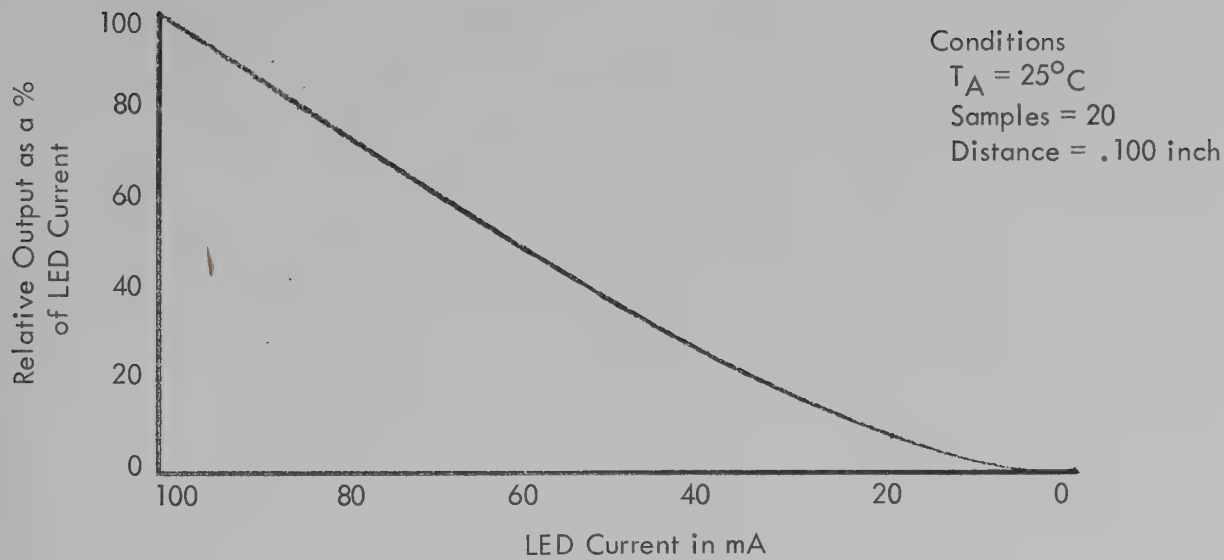
The information shown in "Graph 2" is a plot of relative output versus distance from the lens tip of the LED. Changing the spacing from the .100" specification to .200" will decrease the output by 27%.

"Graph 3" shows a plot of the relative output of the LED versus DC current through the LED. "Graph 4" shows this same information where the LED is pulsed by a 10 microsecond square wave on an 0.1% duty cycle. "Graph 5" shows a plot of voltage across the LED versus current through it. Graphs 4 and 5 may be used together to calculate average power which must be kept below 50 mw.

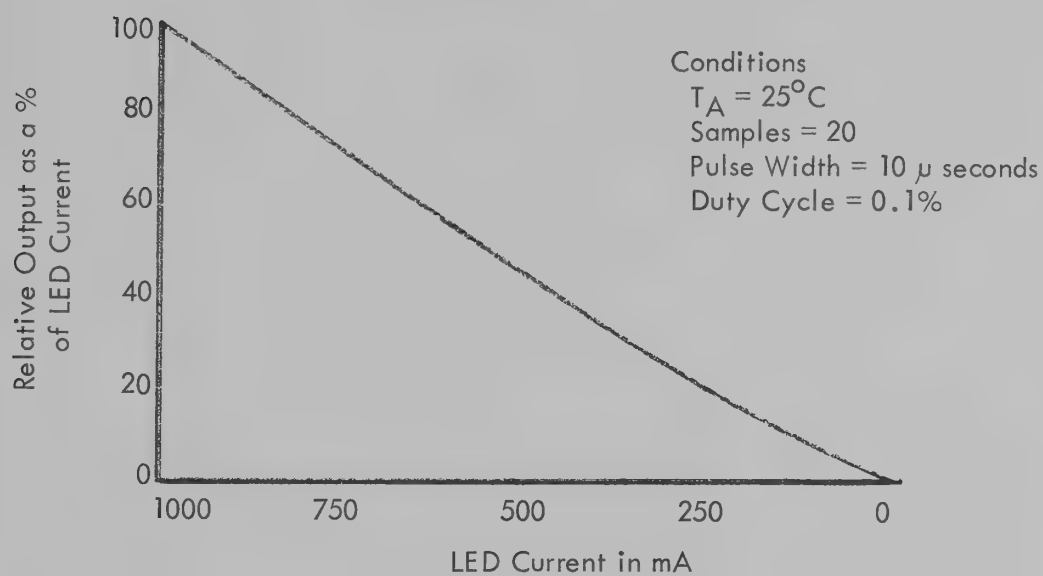
"Graph 6" shows the production variation of output from the LED's. "Graph 7" shows how the output of the LED will vary versus temperature. This information can be used to fit the LED, the sensor, and the application together.

The following design data graphs are intended to supplement the OP100 technical data sheets. This information will enable the designer to optimize designs using the OP100 device.

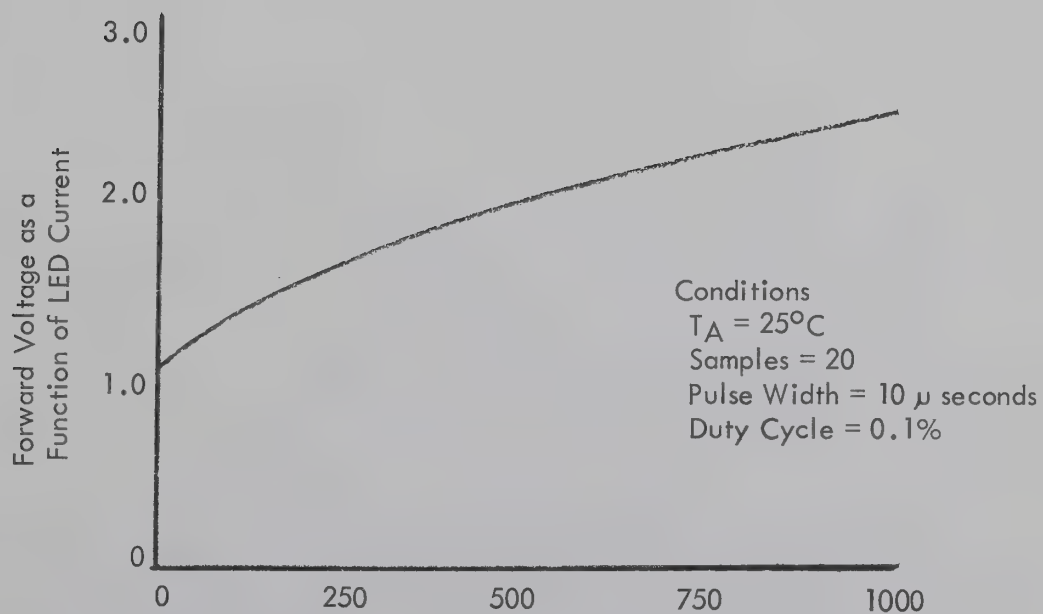




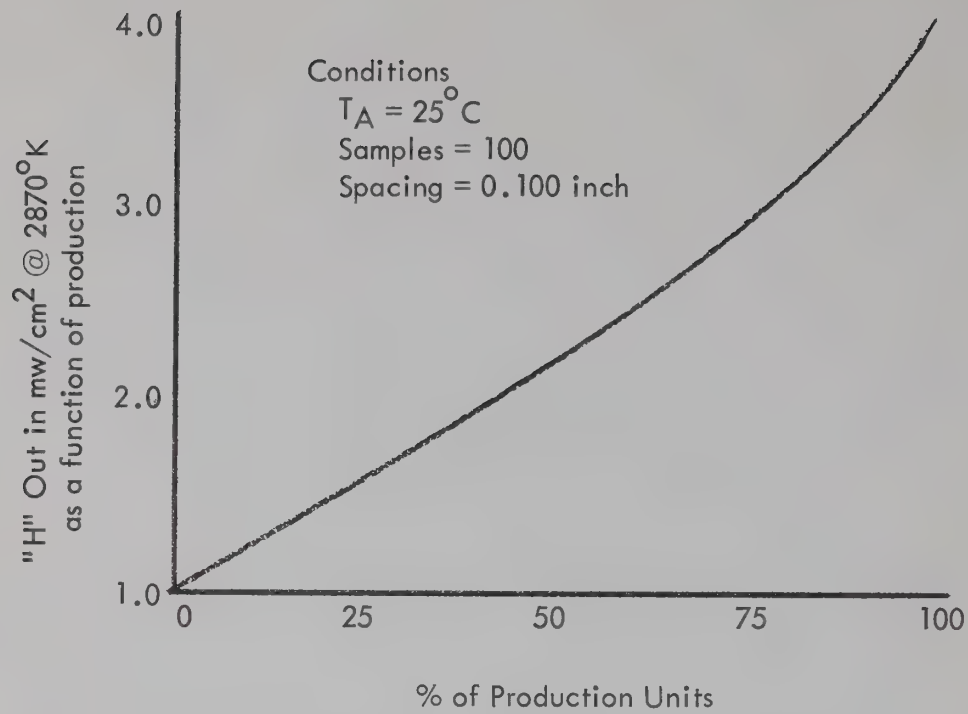
Graph 3



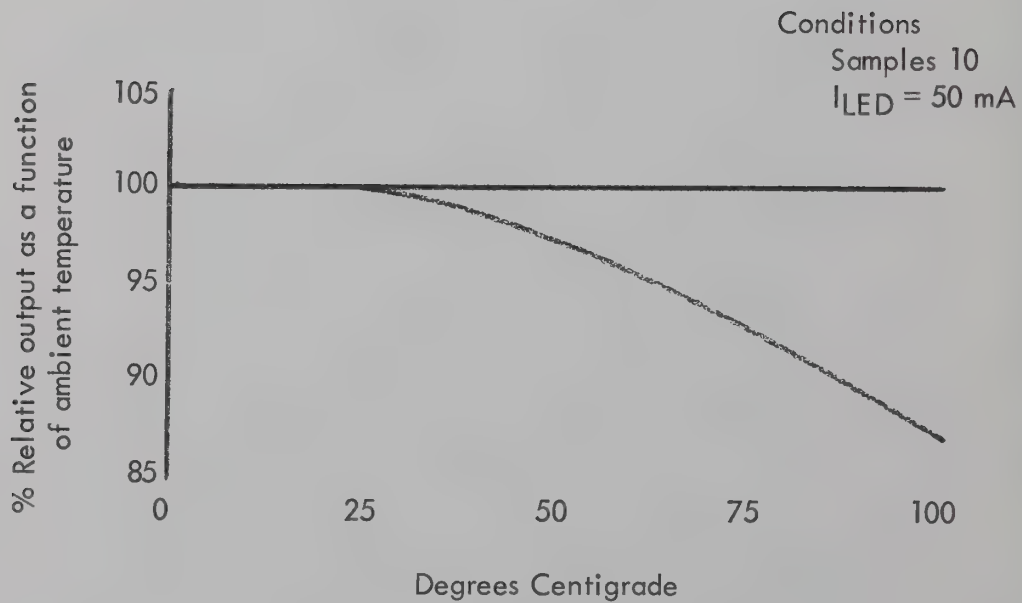
Graph 4



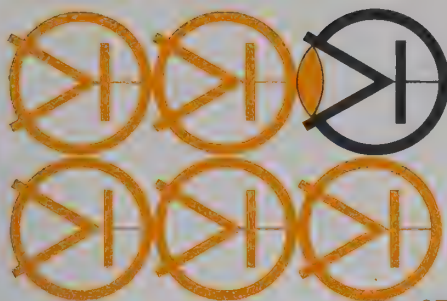
Graph 5



Graph 6



Graph 7



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SWITCHING SPEED OF PHOTOTRANSISTORS

Mike Bunyard
Manager of Applications Engineering

OCTOBER 1, 1970

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APPLICATION BULLETIN NO.16

The lack of sufficient light drive is a problem in many applications using light sensitive transistors. One solution to the problem uses a larger load resistance, but this increases the turn off time. Ideally, some series load resistance should be used for dissipation protection, and the sensor should drive a low input impedance amplifier. Figure 1 shows a connection into an operational amplifier which satisfies both requirements. Figure 2 shows a single transistor buffer amplifier as another choice.

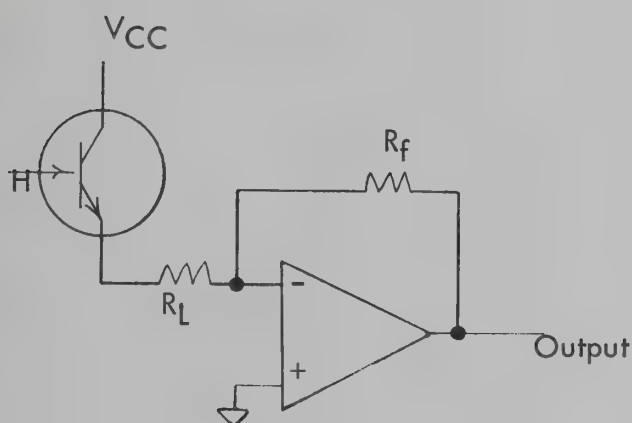


Figure 1

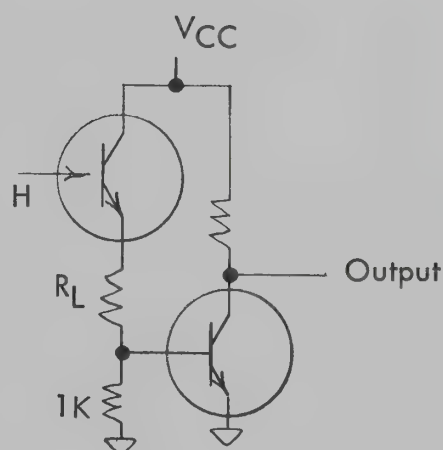


Figure-2

Three tables are shown that display typical values of switching time for the high gain phototransistors in the OP600 family. Table 1 lists values obtained by the standard data sheet measurement circuit, while those listed in Table 2 were obtained by driving the load just to the point of sensor saturation. Values in Table 3 were obtained by driving the sensor loaded with a $1K\Omega$ resistor just to saturation and then keeping the light drive constant. Parameter definitions are listed at the bottom of the tables.

Note in Table 3 that as the load resistance increases, the phototransistor turns on faster, but turns off slower. This differs from the first two tables because the light drive is held constant for the data in Table 3. Switching times listed in Table 2 are generally longer since ΔV across the device is greater for Table 2.

The gain of the phototransistor also influences the switching time with the higher gain units having slower switching speeds. Typical switching times for .8 mA currents are given in Table 4 for the OP600 family.

Table 1			Table 2		
R_L	t_r us	t_f us	R_L	t_r us	t_f us
100	2.8	2.6	510	7.5	7.5
510	8.5	7.9	1K	13.5	12.5
1K	13.0	12.4	2K	28	24
2K	24	24	3K	45	35
3K	37	32	4K	65	45
4K	50	40	5K	75	55
5K	60	47	6K	82	65
6K	72	56	7K	90	75
7K	90	64	8K	120	86
8K	105	72	9K	138	92
9K	110	80	10K	150	120
10K	115	84	22K	180	190

Table 3		
R_L	t_r us	t_f us
1K	12.0	12.8
2K	8.0	25
3K	7.3	35
4K	7.0	44
5K	6.9	55
6K	6.6	65
7K	6.5	75
8K	6.5	85
9K	6.4	90
10K	6.4	100
22K	6.3	190
47	5.9	355

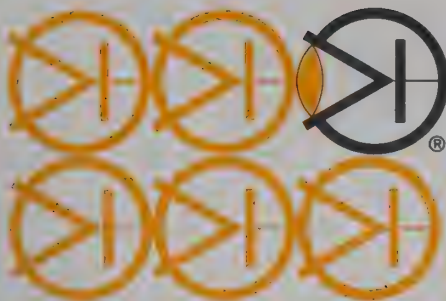
Table 4			
OP601		OP602	
t_r	t_f	t_r	t_f
3.1	2.4	6.5	6.5
OP603		OP604	
t_r	t_f	t_r	t_f
8.0	9.0	13	14

(Values are in μ s)

R_L is series load resistance

t_r is 10%/90% rise time

t_f is 90%/10% fall time



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OPTOELECTRONICS
FOR INDUSTRY

**OPTOELECTRONIC REFLECTIVE
READ-HEAD ASSEMBLIES**

OPB 125 & OPB 253

JUNE 30, 1971

NEW PRODUCT APPLICATION NO. 20

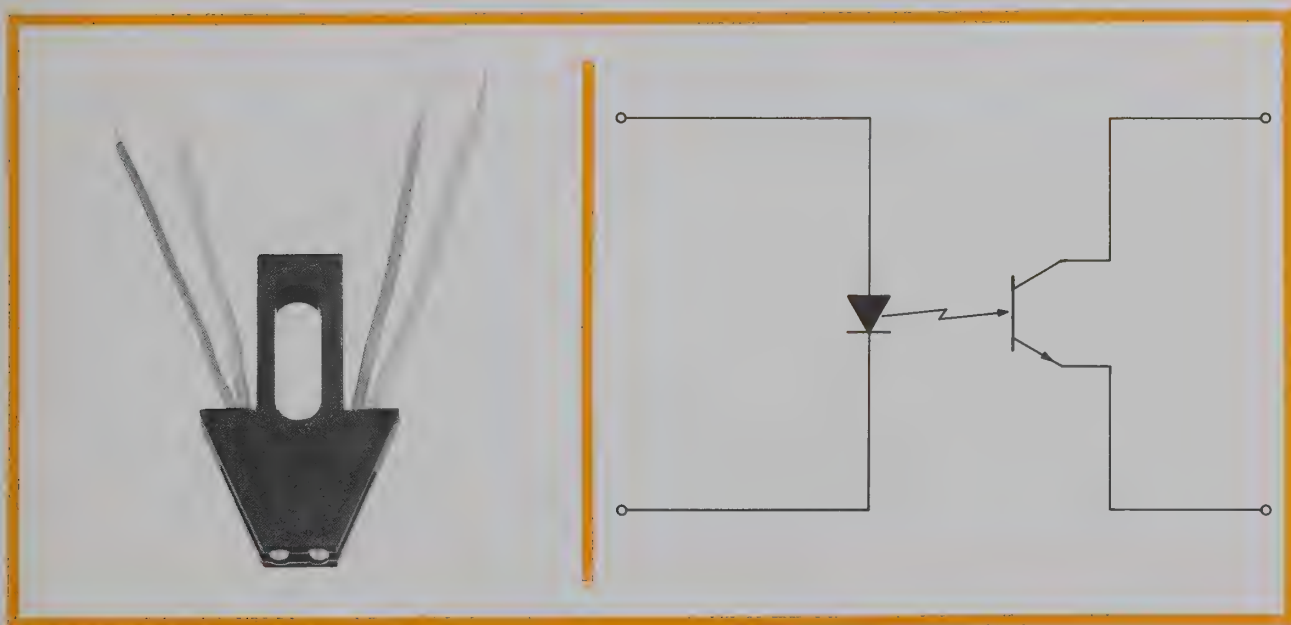
DEL STEFFEN & ASSOC., INC.

653 ALPHA DRIVE - 433

CLEVELAND, OHIO 44143

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- **TTL Compatibility**
- **Rigid Lightweight Plastic Housing**
- **Selectable Sensitivity and Speed Ranges**
- **All Solid State for Durability and Reliability**
- **Designed for Small Size and Stacking**



General Description

The OPB 125 and OPB 253 read-head assemblies provide a LED and phototransistor optimally positioned for close range mark-sense applications. The LED and sensor are mounted in a molded, non-reflective plastic housing. Two speed and sensitivity ranges are available to allow design flexibility.

Electrical Specifications

SENSOR absolute maximum ratings at 25°C free-air (unless otherwise specified—see note 1)

SYMBOL	PARAMETER	OPB 125			OPB 253			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
V_{CEO}	Collector-to-Emitter Voltage	15	25		25	40		volts
V_{ECO}	Emitter-to-Collector Voltage	5	7		5	7		volts
P_d	Power Dissipation (see note 2)			65			65	mw

EMITTER absolute maximum ratings at 25°C free-air (unless otherwise specified—see note 1)

SYMBOL	PARAMETER	OPB 125 and OPB 253	UNIT
V_R	Reverse Voltage	2	volts
I_F	Forward Current (see note 3)	50	mA
I_p	Peak Forward Current	1000	mA

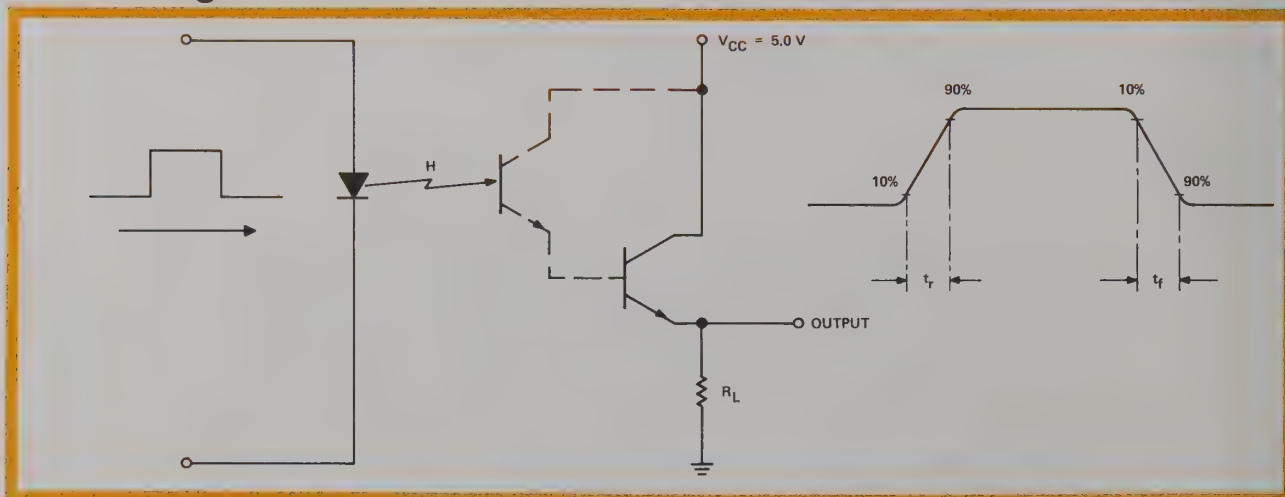
ASSEMBLY absolute maximum ratings

SYMBOL	PARAMETER	OPB 125 and OPB 253	UNIT
T_{op}	Operating Temperature	0 to +70 +32 to +158	°C °F
T_{st}	Storage Temperature	0 to +85 +32 to +185	°C °F

ASSEMBLY electrical characteristics at 25°C free-air (unless otherwise specified)

SYMBOL	PARAMETER	OPB 125			OPB 253			UNIT	TEST CONDITIONS
		MIN	TYP	MAX	MIN	TYP	MAX		
V_F	LED Static Forward Voltage	1.3	1.5		1.3	1.5		volts	I_F (LED) = 50 mA
BV_{CEO}	Sensor Forward Break-down Voltage	15			25			volts	I_{CEO} = 100 μ A
BV_{ECO}	Sensor Reverse Break-down Voltage	5			5			volts	I_{CEO} = 100 μ A
I_L	Phototransistor Light Current	2		10	.025		.25	mA	I_F (LED) = 40 mA, V_{CE} = 5.0 V, White Bond Paper Finish @0.2" Nom.
I_D	Phototransistor Dark Current			1			.01	mA	I_F (LED) = 40 mA, V_{CE} = 5.0 V, Black Matte Finish @0.2" Nom.
$V_{CE}^{(sat)}$	Phototransistor Saturation Voltage	.6	1					volts	I_L = 2.0 mA
t_r	Phototransistor Current Rise Time (see note 4)	75				.15	.4	μ sec	I_L = .40 mA V_{CE} = 5.0 V, I_L = .80 mA R_L = 1000 ohms
t_f	Phototransistor Current Fall Time (see note 4)	75				2.5		μ sec	V_{CE} = 5.0 V, I_L = .80 mA R_L = 1000 ohms

Switching Time Test Circuit



- NOTES:
1. Ratings at which device performance may be impaired if exceeded.
 2. Derate linearly to 70°C free-air temperature at the rate of 0.5 mw/°C.
 3. Derate linearly to 70°C free-air temperature at the rate of .5 mA/°C.
 4. Irradiance is supplied by pulsing the LED. Peak I_F is adjusted to establish I_L .

Physical Specifications

LEADS (solderable and weldable)

Size: .010 diameter x 1.2 inch min. length

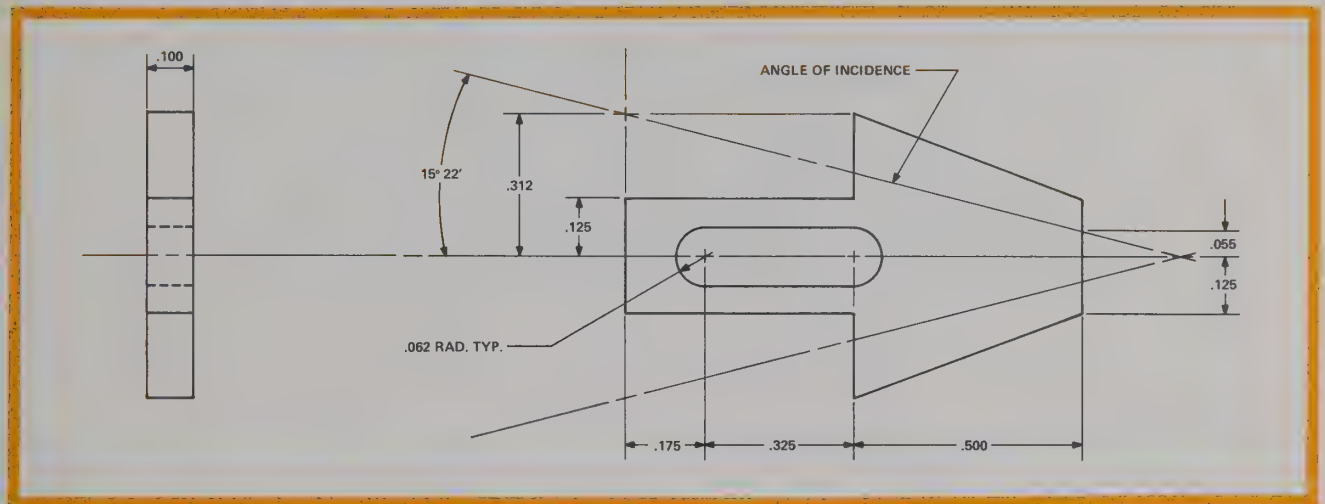
Insulation: Polyvinyl chloride or teflon

Color:

	OPB 125	OPB 253
LED Anode	White	Black
LED Cathode	Green	Green
Sensor Emitter	Orange	Blue
Sensor Collector	White	White

Package: Glass-filled NORYL, molded

Dimensions



Systems Applications

Typical Functions

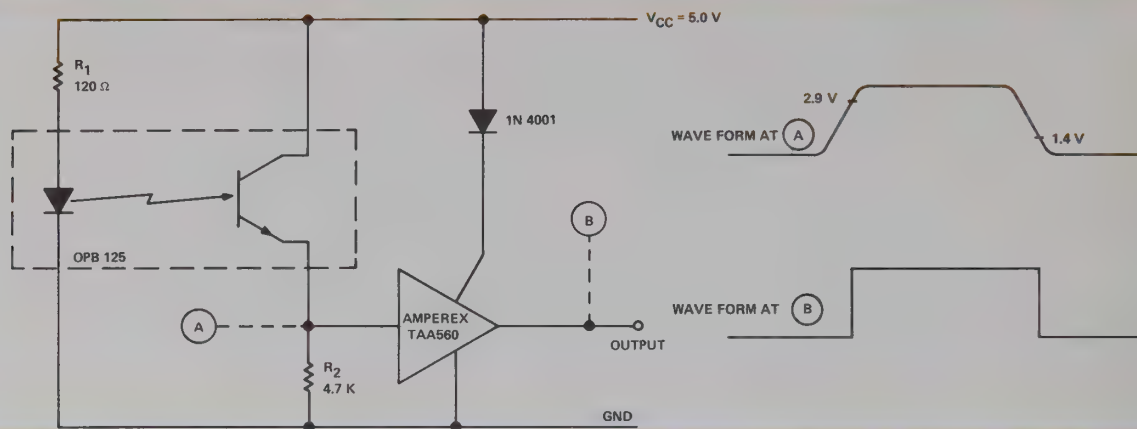
- Mark Sense
- End of Tape Sense
- Proximity Detection
- Flaw Detection
- Punched Tape Reading
- Reflectance Measurement

System Considerations

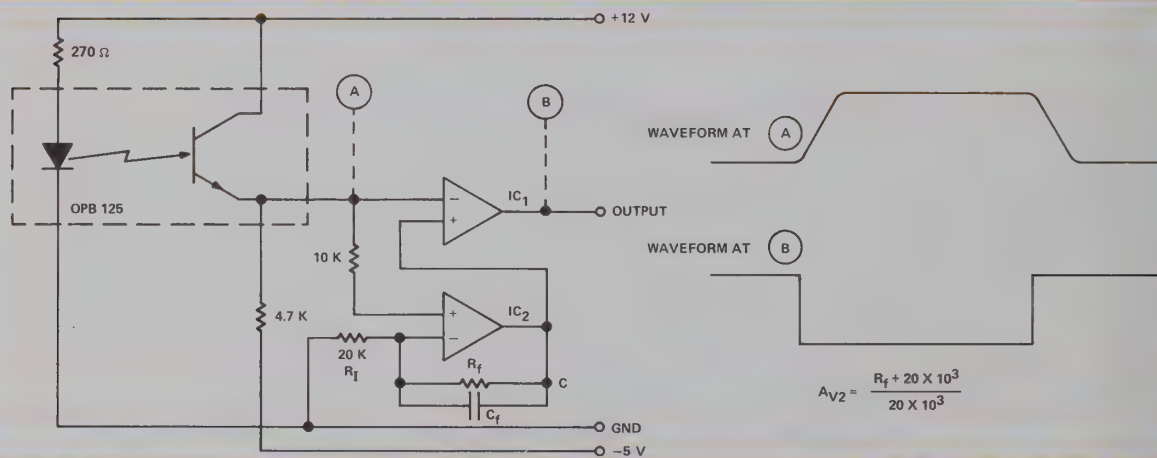
Although I_L is given for white bond and black matte surfaces, it will usually be necessary to make tests using specific materials and sensing distance of the specific system. The irradiance level may be adjusted by varying the LED current within the specified level.

The sensing unit is receptive to all light within its spectral bandwidth, regardless of source. Thus, the system must be designed to reduce glare and reflections to lower the background noise to acceptable levels.

Although specific sensor-to-interface circuitry will be determined by the application, Circuit No. 1 is offered for consideration and guidance.



Circuit No. 1 The voltage developed across the 4.7 K resistor (R2) by I_L will activate the Schmitt Trigger/amplifier. As the input rises past the threshold, regenerative feedback causes the output to go high, with a rise time (t_r) of nanosecond duration, regardless of the rate of change of I_L . As I_L decreases, the lower threshold will be crossed and the output will switch back at the same fast rate. A built-in hysteresis of 1.5 volts guards against false triggering and instability. The output is directly compatible with DTL and TTL integrated circuit logic.

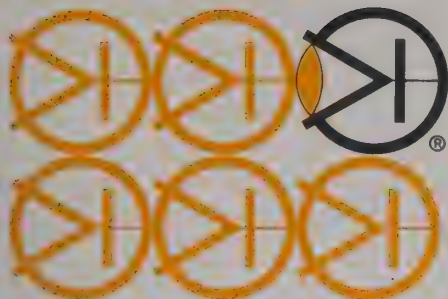


Circuit No. 2 Although the response of Circuit No. 1 is very fast after the threshold is reached, considerable delay may be encountered before the threshold is reached. Circuit No. 2 shifts the comparison voltage at the input of IC 1 by allowing IC 2 to follow the sense input of IC 1 after some delay and with a gain set by R_f of slightly less than unity. Thus R_f can be used as a sensitivity control. For instance, if the gain of IC 2 is .90, the phototransistor need swing through only 10% of its transition before the output is switched.

$$AV_2 = \frac{R_f + R_i}{R_i} = \frac{R_f + 20 \times 10^3}{30 \times 10^3}$$

The delay associated with IC 2 is a function of the rise and fall times of the phototransistor and the time constant set by C_f , R_f and the 20 K resistor.

The output of this circuit is directly compatible with TTL and DTL integrated circuit logic.



OPTRON, INC.

1201 Tappan Circle
Carrollton, Texas 75006
214/242-6571

OPTOELECTRONICS
FOR INDUSTRY

**OPTOELECTRONIC ENCODER
ASSEMBLIES**

OPB 120, OPB 242 & OPB 243

JUNE 30, 1971

NEW PRODUCT APPLICATION NO. 21

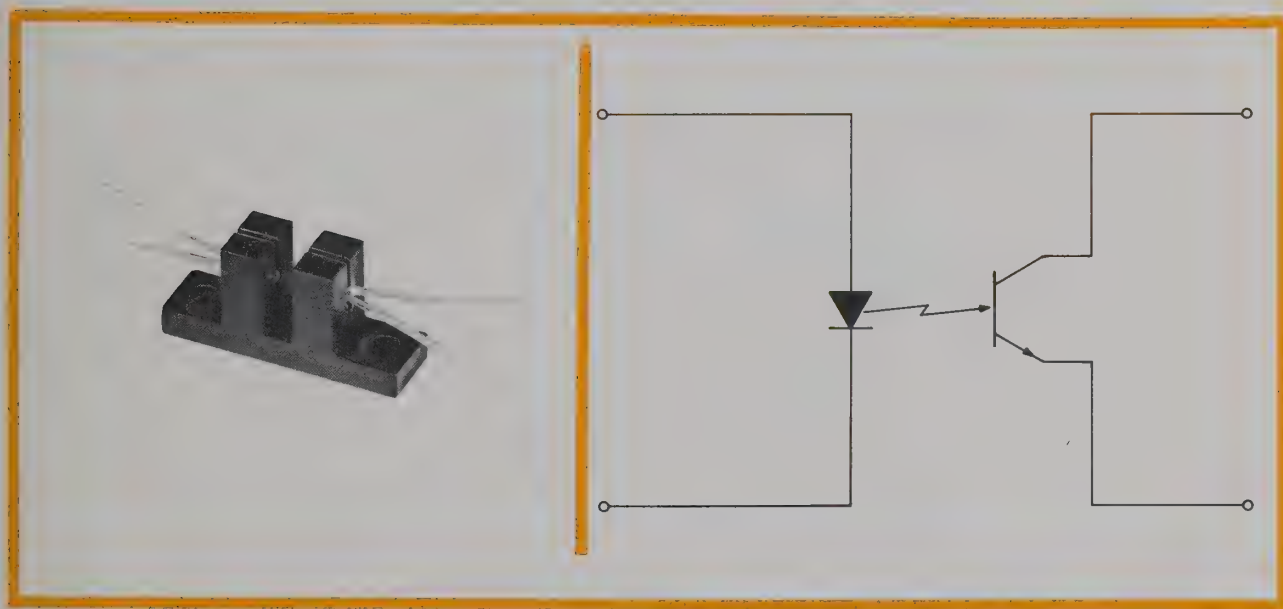
DEL STEFFEN & ASSOC., INC.

653 ALPHA DRIVE - #33

CLEVELAND, OHIO 44143

PHONE: (216) 461-8333

- **TTL Compatibility**
- **Guaranteed Transfer Ratio**
- **Non-reflective Package**
- **Compact, Easily Mounted Assembly**
- **Precision Fixed LED-Sensor Alignment**
- **All Solid State for Durability and Reliability**



General Description

An all solid state infrared LED source and phototransistor are precision mounted in a rugged, compact assembly. These assemblies are designed for application in rotary encoders, angular timing systems and motion counters. Three different speed and sensitivity ranges are provided for optimum design.

Electrical Specifications

SENSOR absolute maximum ratings at 25°C free-air (unless otherwise specified—see note 1)

SYMBOL	PARAMETER	OPB 120	OPB 242	OPB 243	UNITS
V_{CEO}	Collector-to-Emitter Voltage	25	25	15	volts
V_{ECO}	Emitter-to-Collector Voltage	5	5	3	volts
P_d	Power Dissipation (see note 2)	65	65	65	mw

EMITTER absolute maximum ratings at 25°C free—air (unless otherwise specified—see note 1)

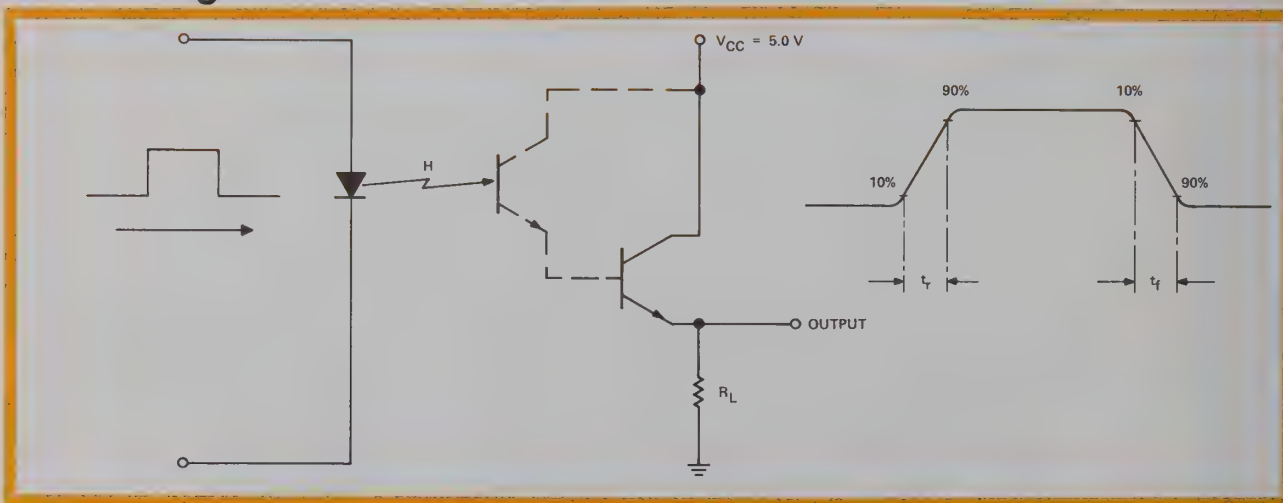
SYMBOL	PARAMETER	ALL TYPES	UNIT
V_R	Reverse Voltage	2	volts
I_F	Forward Current (see note 3)	50	mA
I_p	Peak Forward Current	1000	mA

ASSEMBLY absolute maximum ratings

SYMBOL	PARAMETER	ALL TYPES	UNIT
T_{op}	Operating Temperature	0 to +70 +32 to +158	°C °F
T_{st}	Storage Temperature	0 to +85 +32 to +185	°C °F

ASSEMBLY electrical characteristics at 25°C free—air (unless otherwise specified)

SYMBOL	PARAMETER	OPB 120			OPB 242			OPB 243			UNIT	TEST CONDITIONS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
V_F	LED Static Forward Voltage		1.3	1.5		1.3	1.5		1.3	1.6	volts	I_F (LED) = 50 mA
BV_{CEO}	Sensor Forward Breakdown Voltage	25	50		25	50		15	25		volts	$I_{LED} = 100 \mu A$
BV_{ECO}	Sensor Reverse Breakdown Voltage	5			5			3			volts	$I_{ECO} = 100 \mu A$
$V_{CE(sat)}$	Sensor Saturation Voltage	.15	.4		.15	.4					volts	$I_L = .40$ mA
											volts	$I_L = 2.0$ mA
I_L	Sensor Light Current	.80			1.6		6.4	3.2			mA	$I_F = 40$ mA, $V_{CE} = 5.0$ V
I_D	Sensor Dark Current		.10			.10			.30		μA	$V_{CE} = 25$ V
t_r	Sensor Current Rise Time (see note 4)	2.5			2.5	7					μsec	$V_{CE} = 5.0$ V, $I_L = .80$ mA
t_f	Sensor Current Fall Time (see note 4)	2.5			2.5	7					μsec	$R_L = 1000 \Omega$
											μsec	$V_{CE} = 5.0$ V, $I_L = .80$ mA
												$R_L = 1000 \Omega$

Switching Time Test Circuit

- NOTES: 1. Ratings at which device performance may be impaired if exceeded
2. Derate linearly to 70°C at the rate of .5 mw/°C.
3. Derate linearly to 70°C at the rate of .5 mA/°C.
4. Irradiance is supplied by pulsing the LED. Peak I_F is adjusted to establish I_L .

Physical Specifications**LEADS** (solderable and weldable)

Size: .010 diameter x 1.2 inch min. length

Insulation: Polyvinyl chloride or teflon

Color:

LED Anode
LED Cathode
Sensor Emitter
Sensor Collector

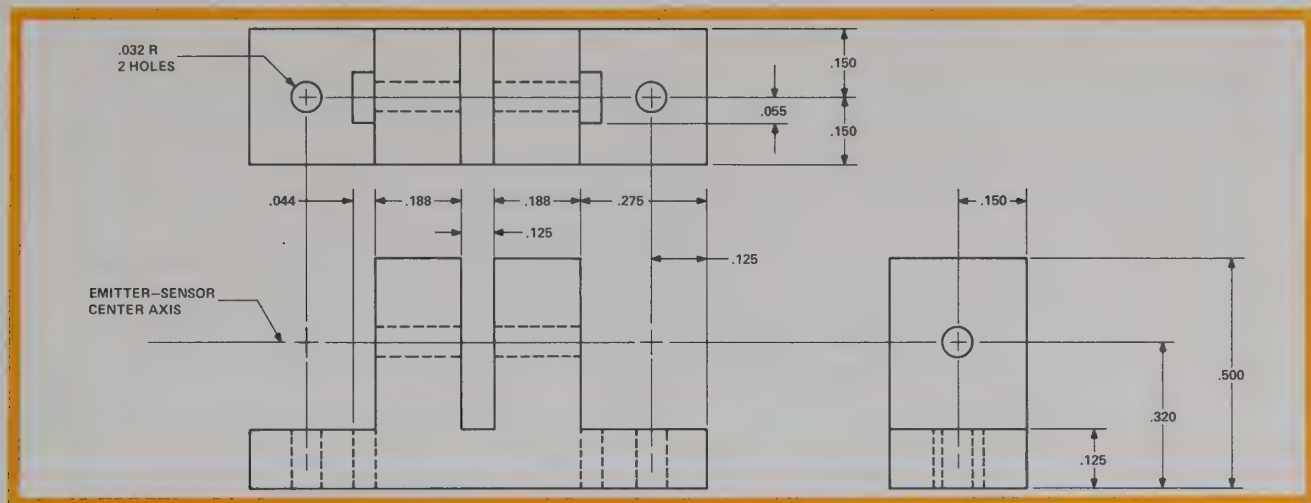
OPB 120
Green
White
Blue
White

OPB 242
Green
White
Yellow
White

OPB 243
Black
Green
Orange
White

Package: Glass filled NORYL, molded

Dimensions



Systems Applications

- Rotary Encoder
- Rotational Phase Detector
- Isolator/Coupler
- Angular Timing
- Tachometer
- Mailing Envelope Sensor

System Considerations

The specifications given do not take into account the possible variations in ambient light level, nor any translucency condition other than that called "transparent". Usage is not restricted to these conditions, however. It is merely necessary to determine the operating system light and dark currents and design from these. A shift up in dark current will occur with ambient light increase, and a shift down in light current will occur with translucent materials. For systems using "transparent" materials as the information carrier, a 25% drop in light current should be allowed for the translucency.

Where the sensitivity of the OPB 243 is required, concern may arise about the switching speed. In most systems mechanical constraints will control the rise and fall times. For example, assume an object moves through the light path, centered between the emitter and sensor, at a velocity (V) of 250 in/sec. With the $\pm 15^\circ$ sensitivity angle of the sensor, the diameter of the area "seen" will be:

$D = 2(\tan 15^\circ) \left(\frac{W}{2}\right)$ (when W is the distance from emitter to sensor and is about .125 inch).

$$D = 2(\tan 15^\circ) (.0625) = .0335 \text{ in.}$$

The fall time of the sensor input light will be the time required to traverse the .0335 inches.

$$\text{Time (T)} = \frac{\text{Distance}}{\text{Velocity}} = \frac{.0335 \text{ in.}}{250 \text{ in/sec}} = 134 \times 10^{-6} \text{ sec.}$$

Compared to the t_r and t_f of the sensor, this is long enough to control the output rise and fall time.

Mechanically, these devices can be used to sense any material crossing the light path larger than about 20 mils and having sufficient opacity to attenuate the light beam, or to deflect it from the sensor. Applications comments will thus be restricted to circuit information.

When the sensor current levels have been determined for the ON and OFF states (sometimes empirically), the circuit design may proceed. The I_L is usually converted to a voltage by a fixed resistor and followed by a voltage amplifier. This converting resistor must be large enough to develop the input voltage for the amplifier, but if too large, the phototransistor will saturate and switching time greatly increases, or false triggering due to "dark" current may occur. The 1000 ohm value used for t_r and t_f testing is an excellent reference point.

Design Example

A 2 inch diameter disc is spinning in the light path at 100

revolutions per second, resulting in a rim speed of 628 inches/second. With a 1/4" slot in the edge of the rim, a "window" of 398 microseconds occurs from the time when the leading edge first passes the sensor to the time when the trailing edge of the slot completely covers the .0335 inch viewing area. The light rise time (or fall time) occurs from the beginning of uncovering (or covering) of the sensor until the action is "complete". In this case:

$$t_r = t_f = \frac{.0335 \text{ in.}}{628 \text{ in/sec}} = 53.4 \times 10^{-6} \text{ sec.}$$

This is much longer than the speed range of the OPB 120 or OPB 242. For operation not limited by device speed, or if response is required very quickly after triggering, one of these devices should be selected. Choose an OPB 120. Assume the minimum on and maximum off currents to be:

$$I_L \text{ on(min)} = .80 \text{ mA}$$

$$I_L \text{ off(max)} = .1 \text{ mA}$$

R_L maximum will be the value that just prevents I_L off (max) from turning on the amplifier. R_L minimum will be set by the minimum voltage required at the amplifier input developed by I_L on (min). Assume V_{in} to be ≥ 1.0 volts if "ON", $\leq .30$ volts if "OFF" and $V_{CC} = 5.0$ volts:

$$R_L \text{ max} = \frac{V_{in \text{ off (max)}}}{I_L \text{ off (max)}}$$

$$R_L \text{ max} = \frac{.30 \text{ V}}{.10 \text{ mA}}$$

$$R_L \text{ max} = 3 \text{ K}$$

$$R_L \text{ min} = \frac{V_{in}}{I_L \text{ on (min)}} = \frac{1.0 \text{ V}}{.80 \text{ mA}} = 1250$$

Select a 1500 ohm resistor.

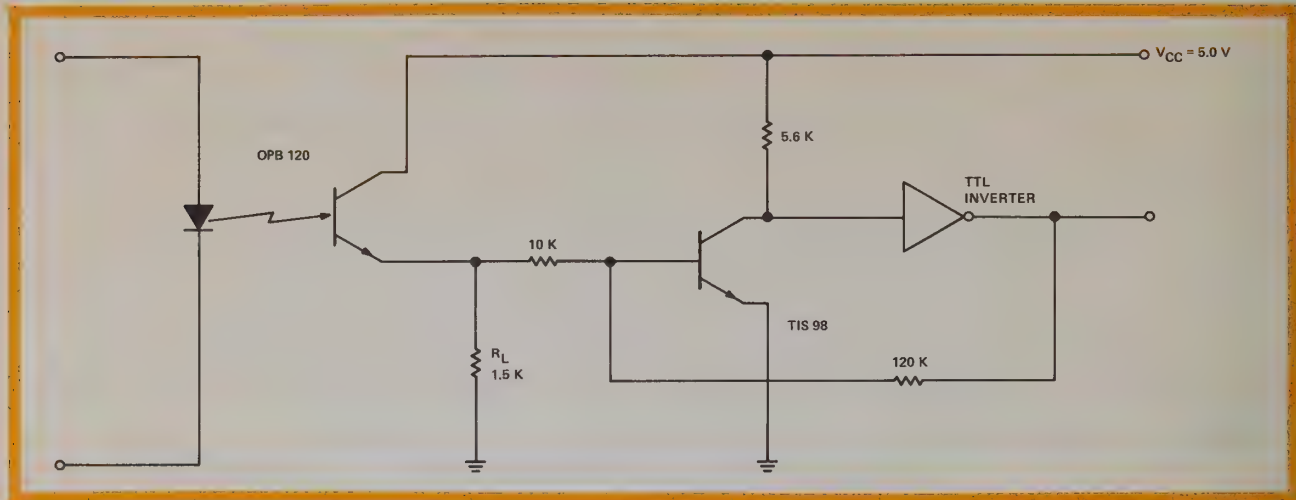
To check the off state voltage:

$$V_{in} = I_L \text{ off (max)} \times R_L$$

$$V_{in} = .10 \text{ mA} \times 1500 \Omega$$

$$V_{in} = .15 \text{ volts}$$

Figure 1

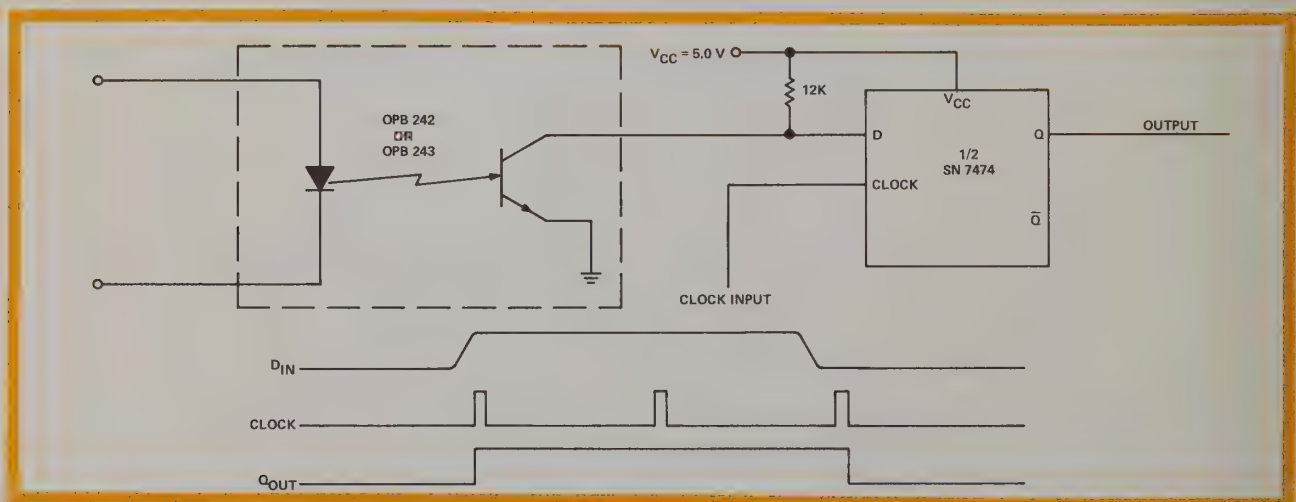


A Schmitt Trigger circuit to interface the OPB 120 to logic systems.

Neglecting amplifier input currents, a 1.5 K resistor would be used. Since t_r and t_f are measured at 1 K, these may be approximated from the data sheet by adding about 20%. Since t_r and t_f of the device are less than the mechanical rise and fall times, the mechanical timing governs.

An amplifier typically showing the indicated input characteristics is shown in Figure 1. The output is DTL and TTL compatible. Schmitt Trigger action makes the amplifier output transition speed independent of its input rise or fall time.

Figure 2



OPB 242 or OPB 243 driving TTL D type flip-flop data input by sinking current.

Where it is necessary to drive logic directly, the OPB 242 or OPB 243 would be selected instead, due to the guaranteed drive capability. It should be noted that some logic configurations become unstable during rise or fall times greater than 1 microsecond. The circuit of Figure 2 drives TTL directly and is stable.



OPTRON, INC.

1201 Tappan Circle
Carrollton, Texas 75006
214/242-6571

O.E.M. PRICE LIST

Effective Date 5-25-73

Page 1 of 3

DEL STUTTEN & ASSOC., INC.

663 ALPHA DRIVE - #33

CLEVELAND, OHIO 44143

PHONE: (216) 461-8333

SILICON PHOTOTRANSISTORS

<u>Device</u>	<u>1 - 99</u>	<u>100-999</u>	<u>Description</u>
OP600	3.15	2.10	Pill Package
OP601	3.15	2.10	Pill Package
OP602	3.15	2.10	Pill Package
OP603	3.80	2.60	Pill Package
OP604	3.80	2.60	Pill Package
OP605	3.80	2.60	Pill Package
OP640	1.31	0.91	Industrial version OP600 series
OP641	1.70	1.29	Industrial version OP600 series
OP642	1.70	1.29	Industrial version OP600 series
OP643	1.90	1.34	Industrial version OP600 series
OP644	1.95	1.40	Industrial version OP600 series
OP645	2.00	1.46	Industrial version OP600 series
OP666	65.00		Photometric Standard
OP800	2.30	1.61	TO-18 Package
OP801	2.40	1.68	TO-18 Package
OP802	2.45	1.72	TO-18 Package
OP803	2.50	1.75	TO-18 Package
OP804	2.60	1.82	TO-18 Package
OP805	2.75	1.92	TO-18 Package
OP700	5.00	3.75	Coaxial Package
OP701	5.40	4.05	Coaxial Package
OP702	5.70	4.29	Coaxial Package
OP703	6.00	4.40	Coaxial Package
OP704	6.60	4.95	Coaxial Package
OP705	7.00	5.25	Coaxial Package

O.E.M. TERMS and CONDITIONS of SALE

PRICES: These prices supersede all previous prices.

BILLING TERMS: Net 30 Days — Prices in effect at time of order.

FOB: City of manufacture, Carrollton, Texas.

MINIMUM ORDER: \$25.00

LIMITED WARRANTY AND REMEDY: Supplier warrants products of its own manufacture against faulty workmanship or the use of defective materials for a period as detailed in the schedule below. This warranty is the only warranty made by Supplier, and is in lieu of all other warranties, express or implied, except as to title, and can be amended only by a written instrument signed by an officer of Supplier. The liability of Supplier under this warranty is limited solely to replacing, repairing or issuing credit (at Supplier's discretion) for any devices which are returned by Buyer during the schedule period provided that (a) Supplier is promptly notified in writing upon discovery of such defects by Buyer, (b) the defective unit is returned to Supplier, transportation charges prepaid by Buyer, and (c) Supplier's examination of such unit shall disclose, to its satisfaction, that such defects have not been caused by misuse, neglect, improper installation, repair, alteration or accident. In no event shall Supplier be liable to Buyer for loss of profits, loss of use, or damages of any kind based upon a claim for breach of warranty.

WARRANTY: Light sensors — One year from date of shipment.

TECHNICAL ADVICE: Supplier's warranty as hereinabove set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of, Supplier's rendering of technical advice or service in connection with Buyer's order or the products furnished hereunder.

NOTE: For special devices not listed and price information on larger quantities than shown, please contact your nearest Optron representative.

SILICON PHOTOTRANSISTORS (Continued)

<u>Device</u>	<u>1 - 99</u>	<u>100-999</u>	<u>Description</u>
OP400	7.50	5.15	Tubular Glass Package
OP440	4.50	3.15	Tubular Glass Package

SILICON PHOTO DARLINGTON TRANSISTORS

OP300	2.40	1.60	Pill Package
OP301	3.00	2.00	Pill Package
OP302	3.00	2.00	Pill Package
OP303	3.00	2.00	Pill Package
OP304	3.00	2.00	Pill Package
OP305	3.00	2.00	Pill Package

PHOTODIODES

OP900	3.80	2.60	Pill Package
OP790	6.00	4.40	Coaxial Package

LIGHT EMITTING DIODES

OP122	3.20	2.14	Pill Package
OP123	4.00	2.68	Pill Package
OP124	4.80	3.20	Pill Package
OP130	3.00	2.00	TO-18 Package
OP131	3.20	2.15	TO-18 Package
OP132	3.25	2.60	TO-18 Package
OP133	3.75	3.00	TO-18 Package

OPTOELECTRONIC REFLECTIVE READHEAD ASSEMBLIES

OPB125	5.80	3.90	Photodarlington - Transistor/LED
OPB253	5.80	3.90	Phototransistor - LED

OPTOELECTRONIC ENCODER ASSEMBLIES

OPB120	5.80	3.90	Phototransistor - LED
OPB243	5.80	3.90	High Gain OPB120
OPB121	5.80	3.90	OPB120 Modified Package

OPTICAL COUPLERS - ISOLATORS

<u>Device</u>	<u>1 - 99</u>	<u>100-999</u>	<u>Description</u>
OP1030	5.85	5.50	5 KV isolation - 40% transfer ratio
OP1031	7.80	6.55	5 KV isolation - 100% transfer ratio
OP1060	5.85	5.50	5 KV isolation - 2.5% transfer ratio
OP1061	7.80	6.55	5 KV isolation - 10% transfer ratio
OP1090	7.80	6.55	5 KV isolation - Photodiode Sensor
OP1050-10	12.00	9.00	10 KV isolation - Photodiode
OP1053-10	12.00	9.00	10 KV isolation - 10% transfer ratio
OP1056-10	12.00	9.00	10 KV isolation - 3% transfer ratio
OP1040	10.00	7.10	15 KV isolation - 3% transfer ratio

	<u>1 - 9</u>	<u>10-99</u>	<u>100-999</u>	
OP1050-50	45.00	37.50	30.00	50 KV isolation - Photodiode Sensor
OP1053-50	45.00	37.50	30.00	50 KV isolation - 10% transfer ratio
OP1056-50	45.00	37.50	30.00	50 KV isolation - 3% transfer ratio

LIGHT SENSOR AND EMITTER ARRAYS & PAIRS

<u>Device</u>	<u>1 - 9</u>	<u>10-99</u>	<u>100-499</u>	<u>Description</u>
OPA505	17.50	14.00	12.60	6 Sensor Tape Reader
OPE505	22.00	17.60	15.75	6 LED Tape Reader
OPB505	39.50	31.60	28.35	OPA505 and OPE505
OPA508	28.00	22.50	19.80	9 Sensor Tape Reader
OPE508	35.00	27.25	24.50	9 LED Tape Reader
OPB508	63.00	49.75	44.30	OPA508 and OPE508
OPA512	31.00	27.80	24.90	14 Sensor Card Reader
OPE512	37.00	33.30	30.00	14 LED Tape Reader
OPB512	68.00	61.10	54.90	OPA512 and OPE512
OPA518	40.00	36.00	30.00	20 Sensor Mini Card Reader
OPE518	60.00	48.00	44.10	20 LED Tape Reader
OPB518	100.00	84.00	74.10	OPA518 and OPE518

Note #1: For 2" leads welded on, add 10% to basic unit price.

